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REPORT DAAK-70-80-C-0147



DESIGN OF MOBILE PHOTOVOLTAIC POWER SYSTEMS: 0.5-3 kW

l October, 1981

Final Report

Prepared For
Mobility Equipment Research & Development Command
Ft. Belvoir, Virginia

Roy D. Gibson

Approved for public release;
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Roy D. Gibson

SOLAREX CORPORATION 1335 Piccard Drive Rockville, Maryland 20850

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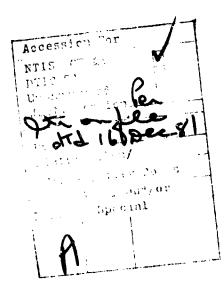
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PREFACE

This effort is an extension of earlier design and hardware development by MERADCOM personnel which included a 2.65 kW photovoltaic system for a telephone communications van and a trailer mounted 800 watt photovoltaic system for general purpose power. The author wishes to acknowledge the support of two major consultants on this project -- Monegon LTD (Hal Macomber) and Fred Costello Associates, (Fred Costello). Furthermore, the author wishes to thank Sam Cerami and Tony Smith of MERADCOM for their invaluable assistance and direction during this project.

SECTION 1

INTRODUCTION

In the conduct of its various operations the U.S. Army requires the support of mobile electric power generating sources. At the present time most of this need for mobile electric power is met by engine-generator sets. The U.S. Army Mobility Equipment Research and Development Command (MERADCOM), however, has the responsibility to develop new or improved cost-effective equipment which will meet future U.S. Army needs for mobile electric power generating sources. Among the potential new power systems which MERADCOM has been examining are solar photovoltaic power systems.

MERADCOM's examination of photovoltaic systems has consisted of a sizable number of system demonstrations ranging from relatively small systems such as secondary battery chargers to larger systems supplying a portion of the base power for a remote radar tracking and communication site. Included in these demonstrations have been two mobile photovoltaic power systems. One of the mobile systems provided 2.65 kW peak power for a telephone communications van. The

solar cell array for this system was attached to the van body and designed to be opened for solar radiation collection during operations. An electric storage battery also was incorporated into the van design.

The other mobile photovoltaic power system demonstrated by MERADCOM was trailer mounted and consisted of the solar cell array, battery storage and power handling equipment.

Each of the photovoltaic systems demonstrated by MERADCOM were composed of existing "off-the-shelf solar cell modules, storage batteries and power handling equipment (where appropriate). In light of the advances technically and economically being made in photovoltaic power systems, as well as the favorable results from MERADCOM's photovoltaic demonstrations, MERADCOM solicited for a study of potential near-term characteristics of a family of transportable photovoltaic power systems. The study sought by MERADCOM called for a determination of optimum sizes and power ratings for the family of transportable photovoltaic systems which could be used in a variety of locations throughout the world with variable and unpredictable loads in the range of 0.5 to 3 kW.

At the beginning of this contract effort, a meeting was held at MERADCOM to refine the transportability requirements for the photovoltaic system. Specifically, MERADCOM defined

two trailer sizes as system design constraints. Their two trailer sizes were based on

- 1. What a 2 1/2 ton truck could pull cross country (maximum loaded weight of 6,000 pounds).
- 2. What a 3/4 ton truck could pull cross country (maximum loaded weight of 1,000 pounds).

These physical weight and extrapolated size limitations together with the conditions that the array could be mounted in a reasonable time by two soldiers and that the battery was accessible for maintenance with the array in a stowed configuration led to the definition of study boundary conditions.

This contract effort can be summarized by four technical tasks which were:

- O Task 1 Analysis of Engine-Generator Inventory and
 Use for, <5 kW system;
- o Task 2 Parametric Analysis of the Transportability of Photovoltaic System, i.e., the range of size and weight of transportable trailers and the associated PV generator size;
- o Task 3 Preliminary Cost Estimates for Photovoltaic Systems; '
- o Task 4 Preliminary Photovoltaic System Design.

Section 2 of this report presents the results of Task 1 for the engine generator set planned inventory and character-

configurations which would be compared with the enginegenerator characteristics identified in Task 1. Section 3 of this report presents the results of the parametric study of sizing trade-offs between photovoltaic arrays and battery storage capacities which were capable of at least meeting the identified engine-generator characteristics.

The parametric analysis of photovoltaic system transportability conducted in Task 2 focused on structural designs for the photovoltaic array and storage battery for the two trailer configurations. The results of this effort are presented in Section 4.

The preliminary cost estimate support in Task 3 involved life cycle cost analyses for the system sizes studied in Task 1. The results of the cost analyses are presented and discussed in Section 5 of this report.

The Task 4 preliminary system design support consisted of examining the results of Tasks 1, 2 and 3 and determining characteristics of transportable photovoltaic systems. Section 6 presents the results of this design support.

Section 7 of this report contains general conclusions of and recommendations for future efforts.

Descriptions of the computer runs made and copies of the computer output are contained in Appendix A for reference. Appendix B contains detailed analysis of structural forces for the various designs.

SECTION 2

ENGINE-GENERATOR CHARACTERISTICS

The Department of Defense (DOD) publishes a "Military Standard" (MIL-STD-633, the latest revision being 633E) for engine-generator set characteristics entitled "Military Standard-Mobile Electric Power Engine Generator Set Family Characteristic Data Sheets". This Military Standard was prepared for use by all departments and agencies of the DOD in selecting Mobile Electric Power Engine-Generator Sets for applications requiring mobile electric power. The mobile electric power engine-generator sets included in MIL-STD-633 comprise spark ignition (gasoline), and compression ignition (diesel and multi-fuel) engine and gas turbine generator sets which are currently in use within the military services.

The DOD military standard covers the electrical output and general characteristics for the DOD Standard Family of Mobile Electric Power Engine Generator Sets. These mobile electric power engine-generator sets vary in output capacity from 0.5 kW to 750 kW and include electrical power outputs of 28 VDC; 60 Hertz and 400 Hertz in conventional voltage ranges.

A summary of the U.S. Army projected inventory of mobile electric power engine-generator sets for fiscal year 1990 is presented in Table 2-1. For the smaller rated sets from 0.5 kW to 5 or 10 kW, the prime movers for the power generator sets generally are spark ignition engines (gasoline). The larger generator sets from 5 kW and above generally use compression ignition engines (diesel or multi-fuel) as the prime movers.

The study is concerned with engine-generator sets in the 0.5 kW to 3 kW range. A summary of representative data for these engine-generator sets is listed in Table 2-2. These data are taken from MIL-STD-633.

Table 2-1

Projected Army Inventory of

Generator Sets for FY1990

Generator	:	FY	FY	Estimated Fuel
Set Rating	(kW)	1980	1990	Consumption-1980 (Gallons) (1)
1. 0.5	GED	3,910	4,149	275 K
2. 1.5	GED	38,604	43,489	(2) 5,863 K
3. 3.0	GED	34,453	49,317	8,140 K
4. 5.0	GED	27,713	28,625	10,912 K
5. 5.0	DED	868	9,138	136 K
6. 10.0	GED	14,037	17,214	9,415 K
7. 10.0	DED	97	2,545	29.7 K
8. 10.0	GTED		2,340	
9. 15.0	DED	2,696	7,546	1,137.7 K
10. 30.0	DED	2,971	7,486	2,507 K
11. 30.0	GTED	1	4	2 K
12. 60.0	DED	7,271	7,996	12,269 K
13. 60.0	GTED	55	384	207 K
14. 100.0	DED		2,685	
15. 200.0	DED	142	155	1,268 K
16. 506.0	DED(3)	25	[′] 30	15.3 K
17. 750.0	DED	14	14	31.4 K

- Note: 1. Fuel Consumption estimated on operation at one-half rated load, 500 hours, 75% of assets in use over a 12 month period.
 - 2. Standby use. Estimated use 1 hour per month.
 - 3. DED Diesel Engine Driven; GED Gasoline Engine Driven; GTED Gas Turbine Engine Driven

In addition to the electrical characteristics of the engine-generator sets, it is important to the selection of photovoltaic system characteristics which compare with the engine-generators to determine an appropriate reliability factor for these sets. Since system reliability affects system operational availability, the reliability factor chosen should be based upon system operational availability.

While the rated electrical output of the engine-generator sets listed in Table 2-2 should not vary with increasing elevations of application sites for the system sizes listed, larger engine-generator sets must be derated at higher elevations due to thermal considerations. This is contrast to photovoltaic arrays which are likely to have larger outputs at higher elevations due to the combined effects of an average higher clearness factor and lower temperatures than will be found at sea level.

Engine generators also can be characterized as power systems which generally have small initial capital costs. The operational, maintenance and fuel costs for these systems, however, are likely to be high. That is, these sets generally cannot be operated unattended thereby causing labor costs for operations. The requirement for major overhaul after only

Table 2-2
Representative Gasoline Electric Generating Sets
Basic Data

	Net Ibs.	70	125	285	488
Dimensions and Weight	Height (in.)	17	18.5	25	25
mens.ons	₩:Jth (∜n.)	27	20.4	23.8	ું.
ä	Length (in.)	19	27.4	35	39.8
	Life Hours	1,500	1,500	1,500	1,500
Engine	Cooling	Air	Air	Air	Air
Eng	RPM	3,600	3,600	3,600	3,600
	田	1.5	3.0	0.9	10.0
	Voltage Frequency V Hz	09	09	09	09
l Details	Voltage V	120	120	120/208	120/208
Electrical Details	s Service Power Factor	1.0	1.0	8.0	9.0
	Continuous Service Power kW Factor	0.5	1.5	3.0	5.0

1,500 hours together with whatever time is required for less major repairs will tend to make maintenance costs high. Further, the fuel costs including the price paid per gallon, the cost for storing the fuel and the cost for transporting the fuel to the storage site, or to the operating site will be migh and are rising at a rate considerably higher than the inflation rate.

A current advantage of the engine-generator sets is that it requires relatively little land area per kW power delivered. the engine-generators from 0.5 kW to 5 kW require only a land area of 2.24 ft² (.21 M²) to 8.28 ft² (.77 M²) not including area for fuel storage.

A particular advantage of the solar power system over the engine-generator set is its silent operation and, therefore, reduced detectability in a combat situation or interference in any operational situation.

In addition the PV power system can operate unattended, requires no fuels or lubricants and does not pollute the atmosphere or any exhaust.

SECTION 3

PHOTOVOLTAIC SYSTEM SIZING ANALYSES

3.1 Parametric Analysis

The design parameters for a transportable photovoltaic power system place unique constraints on the design procedure for these systems which would ordinarily be highly site specific. Consequently, parameters which are usually independent variables in the design procedure become dependent variables, because of the various use requirements.

For these reasons this system design was performed in a parametric fashion with the objective of producing several well defined transportable systems which perform well in a variety of circumstances. Because performance is so highly dependent on the conditions of use, it was a further objective to provide parametric data in an easily understood format to assist decision makers in assessing the utility of these systems in a wide range of circumstances. The results of these performance objectives are presented in the remainder of this section and Section 6 which covers system characteristics.

The parameters affecting system size include:

- o Location
- o Power Load
- o Load Schequle
- o System Loss of Load Probability
 (resulting from solar insolation availability)
- o Weight Limitation
- o PV Panel and Battery Performance

To look at all the possibilities of these parameters over a wide range of applications and locations was not reasonable and so the following simplifying strategy was implemented.

3.2 System Sizing by Performance Versus Weight

Clearly a limiting condition on system size is the maximum weight which can be towed by the towing vehicle and so it was decided to look at those cases where the full utility of the weight capacity is realized.

Two trailer sizes were given as candidates, a one and one-half ton trailer and a one-quarter ton trailer. Their maximum payload weights for cross-country towing are 5,600 lbs. and 1,000 lbs., respectively. Data regarding the trailer weights and physical characteristics are provided in Table 3-1

and 3-2, respectively. Additional data used in sizing the system are listed in Table 3-3. Also contained in the table are the results of the sizing analysis described in the remainder of this section.

Photovoltaic panels have a power weight ratio and batteries have an energy to weight ratio which influence the optimum design. Further, any combination of array area and battery capacity in a specific location supplying a certain load schedule will result in a certain loss of load probability (LOLP) or availability (availability = 1 - LOLP) based upon the variability of solar insolation conditions at that site, i.e., the effect of consecutive days of inclement weather. If other constraints may be considered equal, availability is a desirable quantity to maximize.

As a general rule in a sunny region with a low probability of cloudy days, fewer days of storage and smaller arrays are required to match the performance of a larger system in less favorable climate. In the less favorable climate there will be some optimal balance of array and storage for any given availability or LOLP.

Table 3-1

Tabulated Data for One and One-Half Ton Trailers

			011 11 011015		
a. Cargo Trailers.	M104	M104A1	M105A1	M105A2	M105A2C
Dimensions inside:					
Height: To top of racks	26. 0:-	3ft 9in	3ft 9in	94-01-	84: 61
— · · · · · · · · · · · · · · · · · · ·		lft 6in	lft 6in	3ft 9in	3ft 9in
To top of side panels		5ft	5ft	lft 6in	lft 6in
Length:	511	310	311	5ft	5ft
Body	Oft 2in	9ft 2in	9ft 2in	9ft 2in	9ft 2in
Rack		9ft 3in	9ft 3in	9ft 3in	9ft 3in
Width:		,	, .	711 0111	716 914
Body	6ft 2in	6ft 2in	6ft 2in	6ft 2in	6ft 2in
Rack	6ft lin	6ft lin	6ft lin	6ft lin	6ft lin
Dimensions overall:				•	*****
Height, less paulin:					
(empty)		8ft 3in	8ft 2in	8ft 2in	8ft 2in
Length		13ft 9-	13ft 9-	13ft 9-	13h 9-
Width	1/2 in	1/2 in	⅓ in	1/2 in	1/2 in
Drawbar coupler	· · · Oft I lin	6ft llin	6ft llin	6ft 1 lin	6ft 11in
(adjustable)	04. 5	2ft 7-	2ft 6-	04. 6	***
(aujus-auc) (,,,,,,,	210 3. 	211 /- % in	211 0- 1⁄4 in	2it 6-	2ft 6-
	and	and	and	¼ in and	1/4 in
	2ft 9-	2ft l l-	2ft 10-	2ft 10-	and 2ft 10-
	¥₄ in	3 / 5in	1/4 in	1/4 in	21(10- 1/4 in
Towing vehicles		2-1/4 T	2-1/2 T	2-1/2 T	2-14 T
•	6x6	6x6	6x6	6x	6x6
Weights: (all models) Payload:					
Cross country	· 3.000 15				
Hard-surface road	4,500 lb				
Vehicles (net)	2,650 іь				
Total:					
Cross country	5,650 lb				
Hard-surface road	· · · 7,150 lb				
b. Water Tank Trailers.	M107A1	M107A2	M107A2C		
Capacity of tank (nominal)		400 gai	400 gal		
Dimensions overall:	100 641		700 641		
Height:					
To top of tank manhole cover	6ft 4-	6ft 4-	6lt 4-		
	¾ in	¾ in	% in		
Length	13ft 7-	13ft 7-	13ft 7-		
•	⅓in	⅓in	⅓in.		
Width	6ft 10-	6st 10-	6f: 10-		
	1/4 in	1/4 in	1/4 in		
Drawbar coupler			•• •		
(adjustable)		2ft 6-	2ft 6-		
	¼ in	¼ in	1/4 in		
	and 2ft 10-	and 2ft 10-	and 2ft 10-		
	¼ in	211 10. Vain	211 10- 14 in		
Towing vehicle		2-14T	2-14 T		
Towing Acurcie	6x6	6x6	6x6		
Weights: (all models)			4		
Payload:	3 335 IL				
-Cross country	5.515 lb				
Hard-surface road	5,615 lb				
Vehicle (Net)					
				-	
c. Trailer Chassis.					
M103A1	M103A2	M103A3	M103A3C	M103A4	M203A4C
Dimensions Overall:					<u>-</u>
Height (to top of	9 4. 4*				
tire!	3ft 4in	3ft 4in	3ft 4in	ेर्दर 4in	3ft 4in
Length	13ft 7-	13ft 7-	13ft7-	13ft 7-	13ft 7-
¼in Width 6ft 10•	⅓in 6ft 10-	}{in 64.10	⅓in 6ft 10-	%in €4.30	⅓in
%in	011 10- ¼ in	6ft 10- ¼ in	% in	6ft 10-	6ft 10-
γ4 τη	74 III	74 111	74 48	1/4 in	⅓ in

Table 3-1 (Continued) Tabulated Data for One and One-Half Ton Trailers

Λ	M103A1	M103A2	M103A3	M103A3C	M103A4	M103A4C
Drawbar coupler				•• •	 -	
(adjustable)	¼ in and 2ft 10- ¼ in	2ft 6- ¼ in and 2ft 10- ¼ in	2ft 6- Kin and 2ft 10- Kin	2ft 6- ¼ in and 2ft 10- ¼ in	2ft 6- ¼ in and 2ft 10- ¼ in	2ft 6- 1/4 in and 2ft 10- 1/4 in
Towing vehicle	2-1/4T 6x6	2-1/4 T 6x6	2-1/3 T 6x6	2-14T 6x6	2-1/2 T 6×6	2-14T 6x6
Weights:	1,560 lb	1,560 lb	1,560 lb	1,560 lb	1,560 lb	1,560 lb
Psyload: Cross country	4,090 lb	4 090 lb	4,090 lb	4,090 lb	4,090 lb	4,090 lb
Hard surface roads	5,590 lb	5,590 lb	5,590 îb	5,590 lb	5.590 lb	5,590 њ
d. Folding Side Shop Van Tra	iler M448	}.				
Dimensions overall: Height (empty) Length Width Van body over chassis	13st 91/2 in Tst 7in					

Van body over chassis	, 51t 6in		
Weights	_		
	Empty	Cross-country	Highway
·Payload:	ə	3000 lb	4500 lb
On wheels		5440 lb	6845 lb
On front gear	335 lb	529 lb	615 lb
Total	2960 lb	5960 lb	7460 lb
Drawbar coupler (adjustable)	2ft 61/4 in.	and 21t 10% in	
Towing vehicle	. 216 ton 6:	r6	

1-19. Data and Service Plates

(fig. 1-15)

Shipping cubage 863 cu ft

The data and service plates are located on the right side frame toward the front of the trailer.

Table 3-2 Tabulated Data for One-Quarter Ton Trailer

Center of gravity forward of the rear axle Empty	Width
(2) Overall dimensions, (see fig 1-2	Type Non-adjustable, non-refillable
and 1-5 for shipping dimensions) Cargo body (inside)	Length Collapsed 10.87 in.
Length 8 ft	Extended
Width 3 ft, 5 in,	Average stroke 6.57 in.
Height	(8) Handbrake. Type Expanding shoe
shipping weights)	Control
Payload	Actuation Mechanical
Cross country 500, lb	(9) Electrical system. 24vdc
Highway	(10) Tires.
Weight on landing leg	Number
Empty 80 lb	Size
Cross country 102 lb	M416, M716, M762,
Highway	$M569^{\circ} \dots 7.00 \times 16$
Weight on wheels	$M416B1, M569B1 \dots 6.00 \times 16$
Empty 350 lb	Ply 6 rating
Cross country 828 lb	(11) Tire inflation.
Highway 1076 lb	Highway 25 psi
(4) Lunette height. 2 ft, 2 in.	Cross country 22 psi
(Two position) 1 ft, 11 in.	Mud, sand, snow 18 psi (12) Wheels.
(5) Axle.	Diameter of stud circle 5.50 in.
Length 4 ft, 10-3 / 4 in.	Number of studs 5
Type Tubular	Rim size
Diameter 2-9 / 32 in.	Material Magnesium alloy
Spindle 1-25/32 in.	(13) Chests.
(6) Springs.	Length 62 in.
Type Semi-elli; 'cal	Height 16 in.
Length (centerline	Number
of eyes, flat)	Material Steel

Note: Custom design should permit cross country payload of 1000 1b.

Designs needing to satisfy a variety of conditions do not have such an optimal point but there is sensitivity to the balance of array and battery over a variety of locations.

3.3 Computer Simulation

As indicated earlier and listed in Table 3-3, a variety of locations were selected representing a broad range of geographical and environmental conditions which might be experienced in Army operations. A computer simulation was set up to take array, battery performance and location as inputs and look at a full range of loads and duty cycles.

Output from the simulation was the LOLP for each load combination for each month of the year.

By a series of iterations which involved varying the balance of battery and array for a fully loaded large trailer and fully loaded small trailer, system sizes were established which had generally better overall performance than others.

For each trailer size, two array and battery size combinations were selected. The sizes selected for the large trailer were 40 m^2 of array with 35 kWh of battery and 60 m^2 of array with 20 kWh of battery while the size combinations for

Table 3~3 Transportable Photovoltaic System Sizing Data

PV PANELS 100 W_p/m² output (standard conditions)
54 lbs./m²

Larger Trailer: Case 1 - 60 m^2 array

Case 2 - 40 m^2 array

Smaller Trailer: Case 1 - 13 m² array

Case 2 - 5 m² array

Case $3 - 3.5 \text{ m}^2 \text{ array (1)}$

BATTERIES 20 Wh/lb. of useful capacity (2)

Larger Trailer: Case 1 - 20 kWh

Case 2 - 35 kWh

Small Trailer: Case 1 - 5.0 kWh

Case 2 - 6.0 kWh

POWER LOADS

125 W to 2 kW with duty cycles ranging from 25 percent to 100 percent

LOCATIONS

Munich, West Germany

Jerusalem, Israel

Seoul, Korea

Albrook A.F.B., Panama Canal

Almeria, Spain

Cambridge, United Kingdom

Honolulu, Hawaii

Juneau, Alaska

San Antonio, Texas

Washington, D.C.

Note: 1. This smaller size of 3.5 M² was analyzed and concluded to be cost ineffective.

2. Based on 50% depth of discharge.

the small trailer were 5 m² with 5 kWh and 3.5 m² with 6 kWh. Battery sizing was based on a 50% depth of discharge. Beyond a certain point the benefit of increasing battery size at the expense of array area fell dramatically in many runs, completely eliminating the utility of the small trailer altogether. As a result, an alternate array size of 13 m² for the small trailer was also analyzed.

For convenient reference the data for both chosen systems in the ten locations are presented in Section 6. Availability is shown for each system and load on an annual average basis. The LOLP figures for extreme months are also shown to give a feeling for seasonal variations in performance. Availabilities worse than 80 percent have been masked with a dashed line and N/A is entered when the array simply cannot meet the load.

For more detailed information, the data tables from which the data in Section 6 were derived, are included in Appendix A.

An example of the computer output format is illustrated in Figure 3-1. For example, for the large trailer with a 60 m² array located in San Antonio, Texas and tilted at 29.5° from the horizontal (latitude) a load of 500 watts continuous (100% duty cycle) could be served with an LOLP of 1.9%. Likewise, for the small trailer with a 13 m² array, a load of 500 watts with a 25% duty cycle could be served with an LOLP of 10.9%.

3.4 System Performance

For reference in the following discussion, the ten sites are rank-ordered from the best system performance at the top to the worst at the bottom.

	Location	Latitude
1.	Jerusalem, Israel	31.8°N
2.	Honolulu, Hawaii	21.3 ^O N
3.	Albrook AFB, Panama	8.6 ⁰ N
4.	Almeria, Spain	37.00N
5.	San Antonio, Texas	29.5 ⁰ ท
6.	Seoul, Korea	37.6 ⁰ N
7.	Washington, D.C.	39.0 ⁰ N
8.	Munich, W. Germany	48.1 ⁰ N
9.	Cambridge, U.K.	52.20N
10.	Juneau, Alaska	53.4 ⁰ N

At a glance it appears that performance in regions approaching the poles is more directly a function of latitude while performance in equatorial regions is more site dependent. On the other hand, close examination of the data for the sites between Seoul and Jerusalem in the performance ranking shows very little distinction between them in annual performance.

LOCATION : SAN ANTONIO, TEX	N I SA	N ANT	0410,	÷t.x	3	LATITUDE : 29.5	29.5								
LG. TRAILER ARRAY (SO. METERS) ; 60.0 SM. TRAILER ARRAY (SO. METERS) ; 13.0	1LER JLER	ARRAY Array	(SO.	METER Meter	(S) 1	13.0	BATTERY SIZE (kWh) ; 20.0 RATTERY SIZE (kWh) ; 5.0	211S	£89	20.0 5.0					
LOAD (WATTS)	ATTS		250				•	200			=	1000			7
* DUTY	25	20		15 1	300	25	20	7.5	100	25		50 75	700	22	20
LG. TRAILER									(((
LOLP		100.1	100	0.0 0.0 0.0 0.0 100.0 100.0 100.0	9.0	0.001	0.0 0.0 0.1 1.9	95.3		100.0			1:		
LOSS OF LOAD EXTREMES MAX 0.0 0.0 0.0 HIM	LOAD 0.0	EXTRE	HES 0	0.0	0.0	9.0	0.0	0.0	0.0	0.0	11.1	11		9.6	11
SH. TRAILER						(
LOLP	160.0	160.0 10.9		11	11			\$ \$	ζ. Υ .	11	** **	\$ \$	\$ \$	* *	* \$
LOSS OF LOAD EXTREMES MAX 0.1 71.1 MIN 0.0 0.0	1.0	EXTRE		LOAD EXTREMES 0.1 71.1 0.0	!!) ::9) <u>:</u> ; e	\$ \$	* * *	1 1	K K K	\$ \$	* * *	4 % 4 %	**

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#/A . #/A #/A . #/A

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\$\$

rigure 3-1. Example Format for Computer Output

How these distinctions and others affect system utility in various applications is taken up in more detail in Section 6.

In addition to an analysis of the performance of the mobile photovoltaic power systems which is based on an annual basis, it is important to consider the effect of seasonal or short term performance. As an example of seasonal performance, Table 3-4 presents the results of the 60 m^2 and $13 m^2$ arrays which are tilted for optimum sun angle for winter and summer in Jerusalem, Israel.

Note that the tilt angle adjustment of 47° for the winter (December-February) in Jerusalem permits a 50% increase in performance for the 60 m² array over the annual performance at latitude tilt. Furthermore, a 17° array tilt for the summer months (April-September) permits a 100% increase for this array sixe.

These roults are important because military field maneuvers may often be conducted for periods of 1-4 months and monthly tables could be derived which would permit the maximum output performance of the arrays to be realized by appropriate array tilt adjustment.

Further results are illustrated in Table 3-5 for San Antonio, Texas where seasonal tilt adjustment permit winter

performance which is at least equal to annual performance results and summer tilt adjustment permit a 50% increase in performance.

Table 3-4

Comparison of Annual vs. Seasonal Performance

Location: Jerusalem, Israel

I. Array Size: 60 m² (Large Trailer)

Array Efficiency: 10%
Battery Capacity: 20 kWh

Load: 2 kW

1-LOLP (Availability): 80% Min.

Max. Monthly Load Met vs. Tilt Angle:

Annual Performance	Seasona	l Performance
Latitude Tilt (31.80)	Winter Tilt (470)	Summer Tilt (170)
2,000W @ 25% (DC)	2,000W @ 37.5% (DC)	2,000W @ 50% (DC)
	Dec - Feb	Apr - Sep

II. Array Size: 13 m² (Small Trailer)

Battery Capacity: 5 kWh

Load: 500 W

1-LOLP: 80% min.

Annual Performance	Seasona	al Performance
Latitude Tilt (31.80)	Winter Tilt (470)	Summer Tilt (170)
500 W @ 25% (DC)	500W @ 25% (DC)	500W @ 25 % (DC)
	Nov - Feb	Apr - Sep

Note: DC - Duty cycle, e.g., 2,000 Watt @ 25% duty cycle is equivalent to 500 watts continuous.

Table 3-5

Comparison of Annual vs. Seasonal Performance

Location: San Antonio, Texas

I. Array Size: 60 m² (Large Trailer)

Array Efficiency: 10%
Battery Capacity: 20 kWh

Load: 2 kW

1-LOLP (Availability,: 80% minimum

Maximum monthly load met vs. Tilt Angle:

Annual Performance	Seasona	al Performance
Latitude Tilt (29.50)	Winter Tilt (44.50)	Summer Tilt(14.50)
2,000W @ 25% DC	2,000 W @ 25% DC	2,000W @ 37.5% DC
	Oct - Dec	May - Sep

II. Array Size: 13 m² (Small Trailer)

Battery Capacity: 5 kWh

Load: 500 W

1-LOLP: 80% minimum

Annual Performance	Seasonal Performance	
Latitude Tilt (29.50)	Winter Tilt (44.50)	Summer Tilt(14.50)
500 W @ 25% DC	500W @ 25% DC	500W @37.5%DC
	Oct - Feb	May - Sep

SECTION 4

STRUCTURAL ANALYSIS

The Conceptual Design of the Structure

In order to better assess the practicality of transportable photovoltaic systems a number of conceptual designs were created for the mechanical and structural systems. Two of these were ultimately selected for detailed analysis to verify the feasibility of the most promising system. One design is intended for application with very small transportable PV systems (3.5 to 13 m² of array) appropriate for towing with a M 141 truck. The other is larger and can manage array sizes up to 60 m² but requires a larger towing vehicle, specifically a 2.5 ton truck.

Several designers were assigned to produce the initial conceptual designs independently so that a variety of independent thoughts and solutions could be available for synthesis in a final design procedure. Each designer, however, was given the same guidelines as follows:

O Total system weight should not exceed 21 lbs./ft 2 (103 lbs/M 2) of array

- o Cost should not exceed \$5/ft² (\$54/M²) of array
- Should be possible to set up by two men in 30 minutes for small trailer and 2 hours for the large trailer.

It was felt that if these minimum criteria could not be met that the system would not be practical.

The two figures following synthesize these designs as they were ultimately selected and integrated into the two final systems. Figure 4-1 and 4-2 shows details of the design concept for the small trailer PV system including many of the structural features which apply to the set up procedure. Figures 4-2 and 4-3, covers the same aspects of the large trailer system.

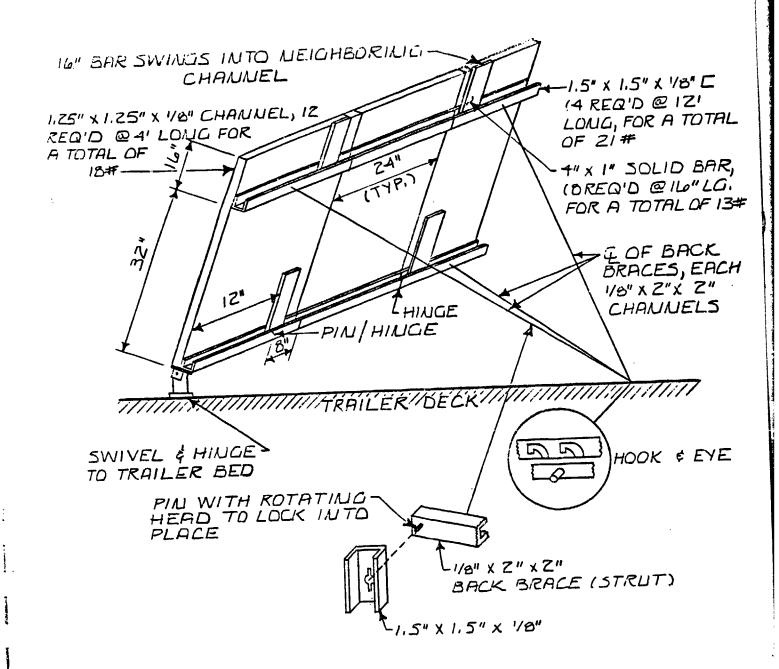


Figure 4-1. PV Panel Detail for Small Trailer System

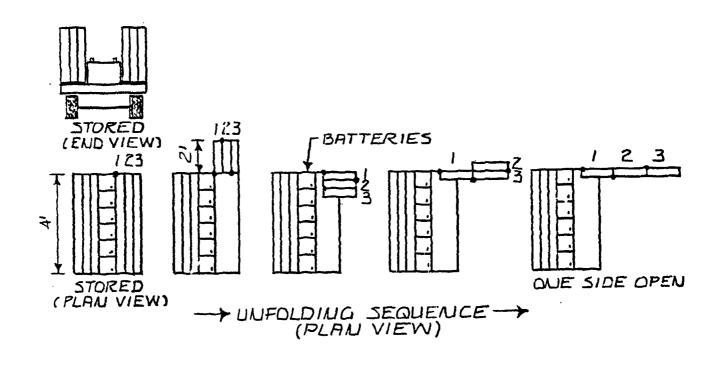


Figure 4-2. Unfolding Sequence for PV Panels for Small Trailer System

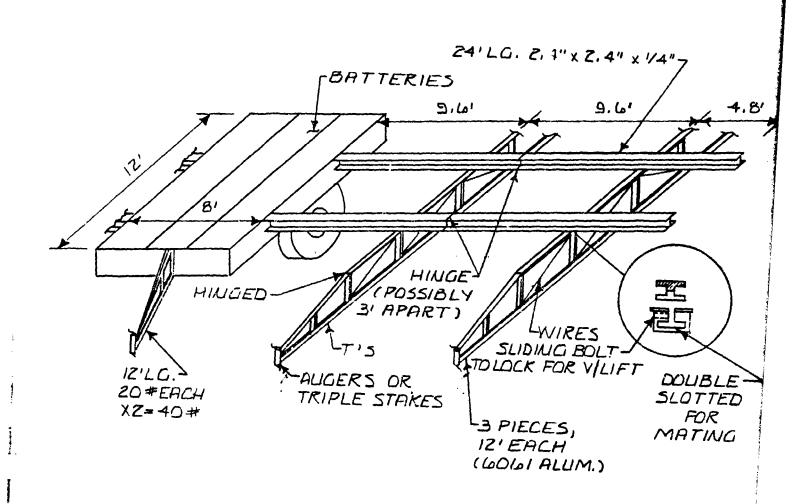


Figure 4-3 Structural support for PV Array on Large Trailer

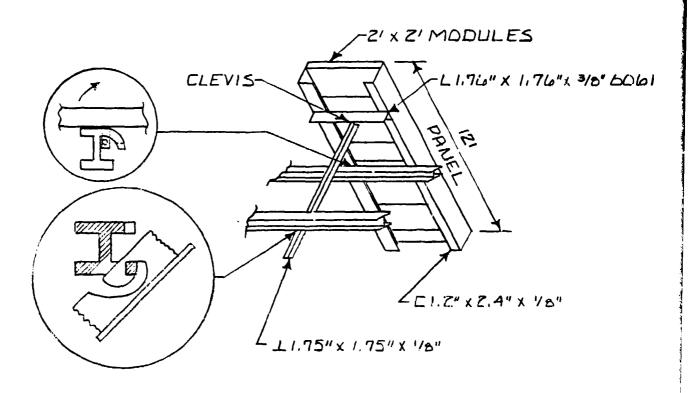


Figure 4-4 Structural Support for Each Panel on Large Trailer

In the next sub-section entitled Methodology, we present some of the background for the final design selections in the way they were arrived at. Based on this methodology the final designs were selected and are described in the final subsection.

Methodology

The recommended conceptual designs were developed in five steps:

- 1. the requirements were defined;
- three independent designers developed concepts;
- 3. the concepts were evaluated in terms of their suitability in meeting the requirements;
- 4. the most suitable designs were evaluated in terms of the stresses, sizes of structural members and resistance to overturning; and
- 5. weights and costs were estimated.

These requirements were developed in a meeting with MERADCOM, held November 24, 1980.

The system was to be erectable within two hours by two men. Disassembly and storing was also to take no more than two hours by two men for the large trailer. Few separate parts were to be used to minimize the risk of loss and the larger trailer was to be no more than 12 feet long, so it would be maneuverable at forward battlefront sites. It was understood that the utility of the transportable systems would be limited by the amount of storage that could be placed on the trailer, but one—day storage was deemed acceptable in many cases. However, the longer the storage, the better the system. The design was to be carried through the conceptual design stage with the intention that the end product should illustrate potential military applications.

The system might be erected for one day or for many days or weeks. It would not be used if the wind velocity exceeded 60 knots, so designs could be based on storing the system during high winds. Erection and storing would be done manually. It was anticipated that the trailer would be towed over all types of terrain, so sufficient ground clearance must be main-

tained. Cost was not to be a major factor, of greater importance is that the user be confident in the operation of the system.

The systems were to range from a size appropriate for a trailer towable by an M 141 truck to one size to fit into a trailer normally towed behind a 2.5 ton army truck. The trailer need not be the standard trailer; even the towing vehicle could be a special vehicle if this departure offered a significant advantage.

Further, it was concluded that the trailer would always carry the full complement of components. Individual users would not unload batteries or panels in an effort to save weight, at the risk of being short on power. Therefore attention was devoted to providing the maximum power that could be delivered by each of the two trailer systems. It was estimated that, for a four foot by four foot trailer, a five square meter array would be reasonable, although the trailer might hold somewhat more. The largest array that could be carried on an eight foot by twelve foot trailer with a small battery pack would be approximately 60 square meters, allowing a two foot by twelve foot plan area for batteries and power conditioners.

The independent results of the three designers preliminary concepts are shown in Figures 4-5 through 4-13.

Tradeoffs among the various concepts were performed qualitatively, as illustrated in Figure 4-11. Although perfect distinction between designs is not possible because each design shares some similarity with others, the differences are sufficiently clear to permit the comparison of Figure 4-14, from which the recommended design was chosen.

The stresses, deflections and overturning resistances were computed by conventional means. The pressure coefficient for the trailer-mounted array is taken to be approximately 3.0, whether the wind is from the front or from the back. Previously, pressure coefficients of 2.0 or less were recommended. For the 60-knot wind, the wind forces will be 44.6 psf. The sizes of the members shown in Figures 4-1 and 4-3 illustrating the recommended design, are based on this wind force.

Once the member sizes had been determined by the allowable stresses and overturning resistances, the weight was readily calculated. The cost was estimated by obtaining a verbal quote for extruded 6061 aluminum and using this cost

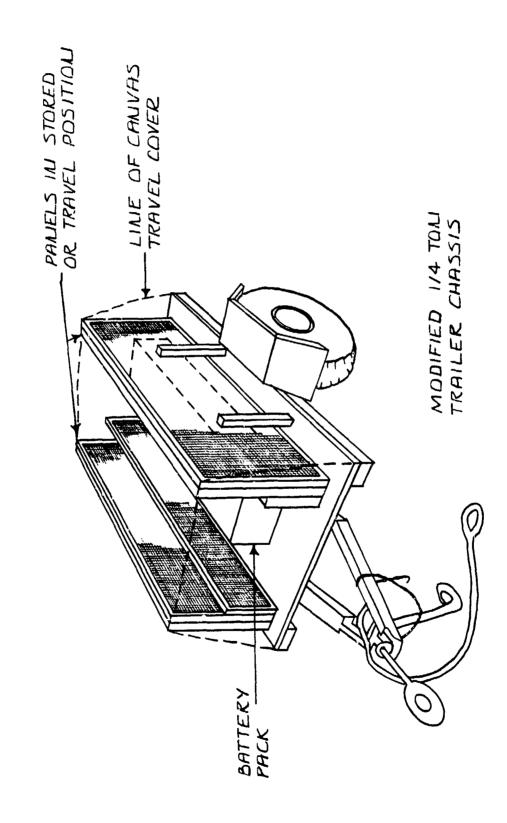


Figure 4-5. Small Trailer System - Panels Folded (Design #1)

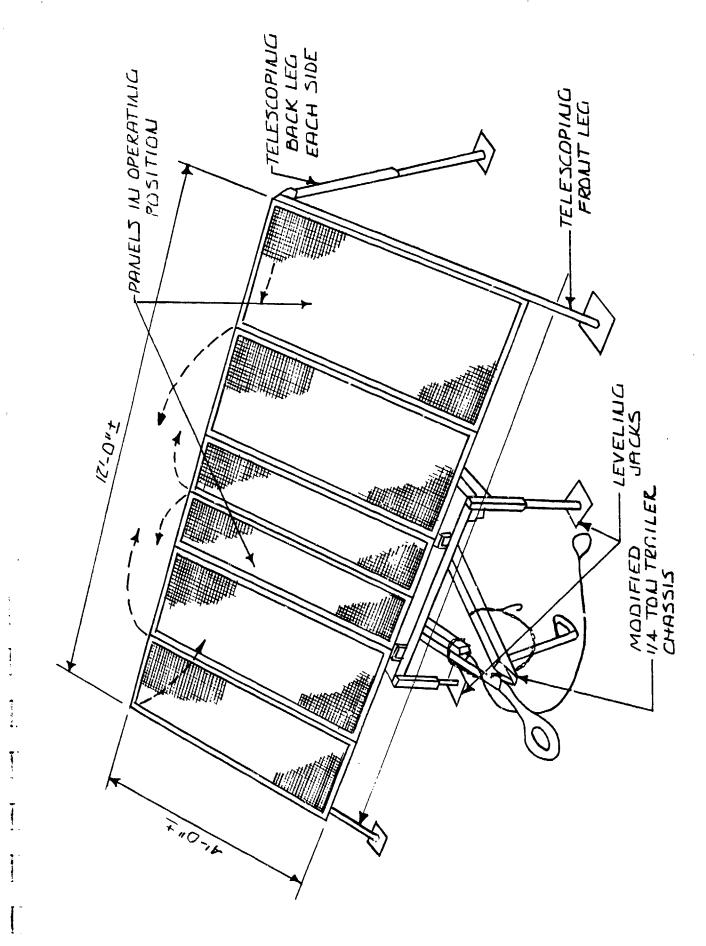
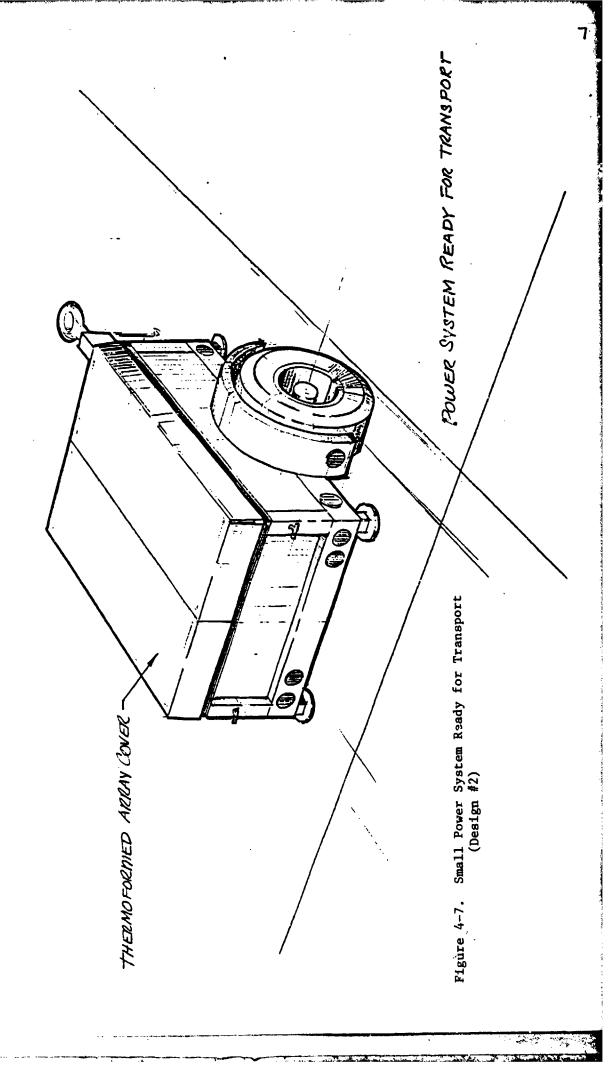


Figure 4-6. Small Trailer - Panels Deployed (Design #1)



(1) REMOYE PROTECTIVE COYER

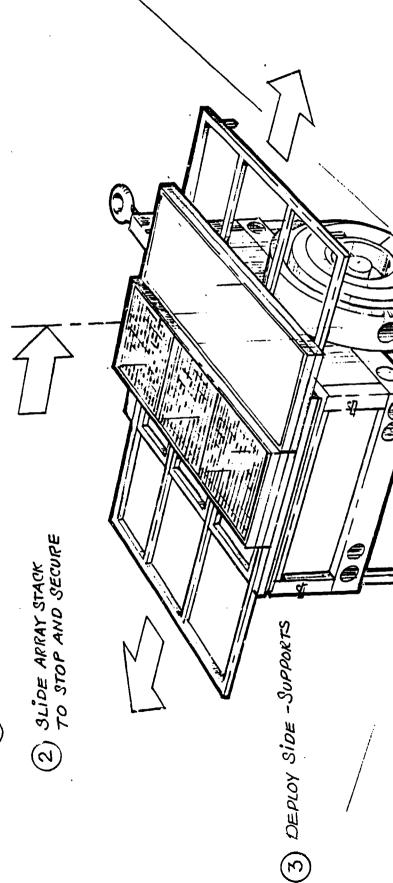


Figure 4-8. Small Power System Partially Deployed (Design # 2)

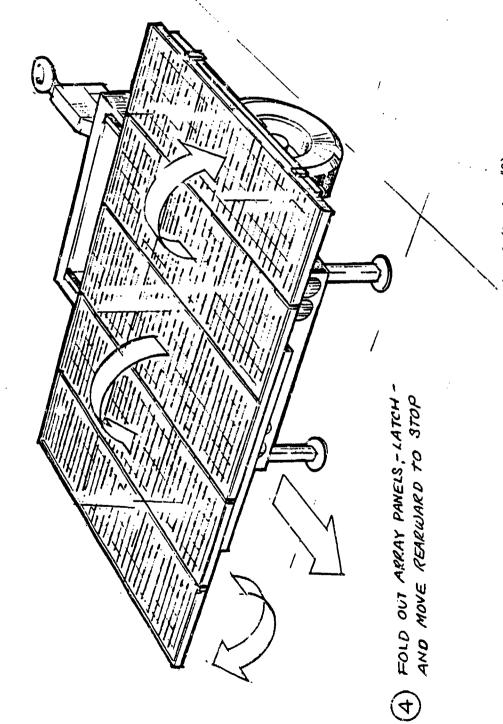
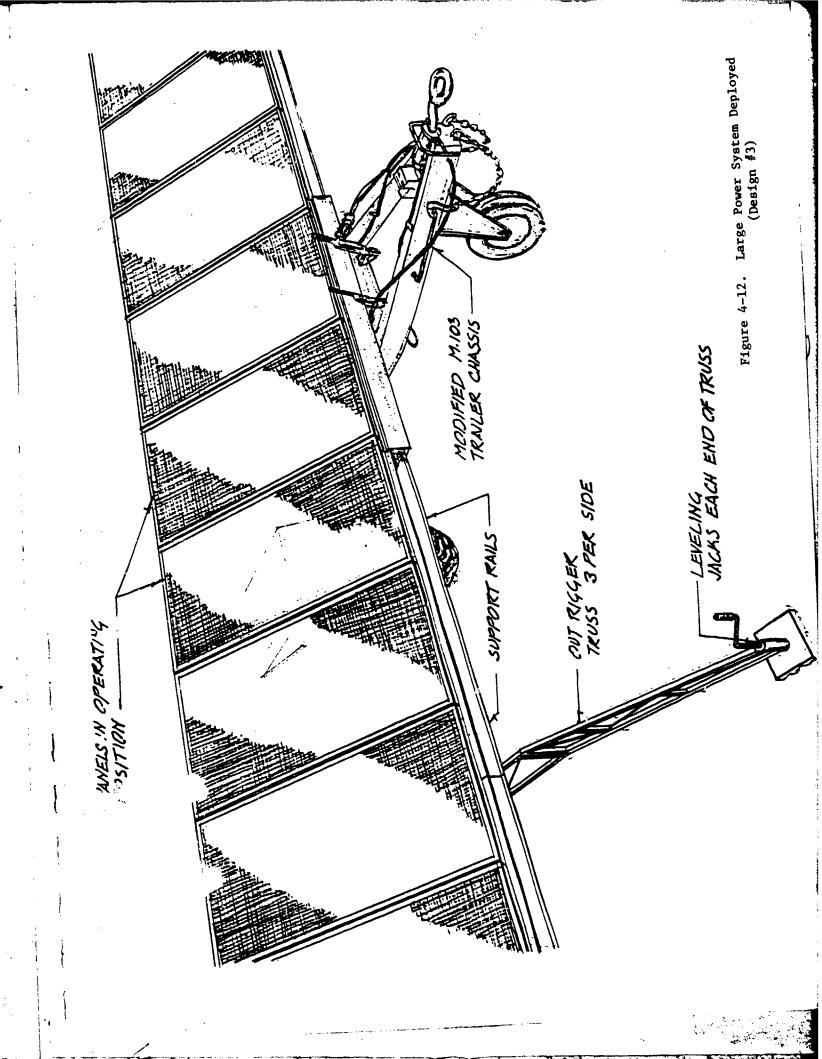


Figure 4-9. Small Power System Further Deployed (Design #2)

PANELS IN TRAVEL OR STORED POSITION LINE OF CANYAS TRAYEL COVER

Figure 4-11. Large Power System - Folded (Design #3)



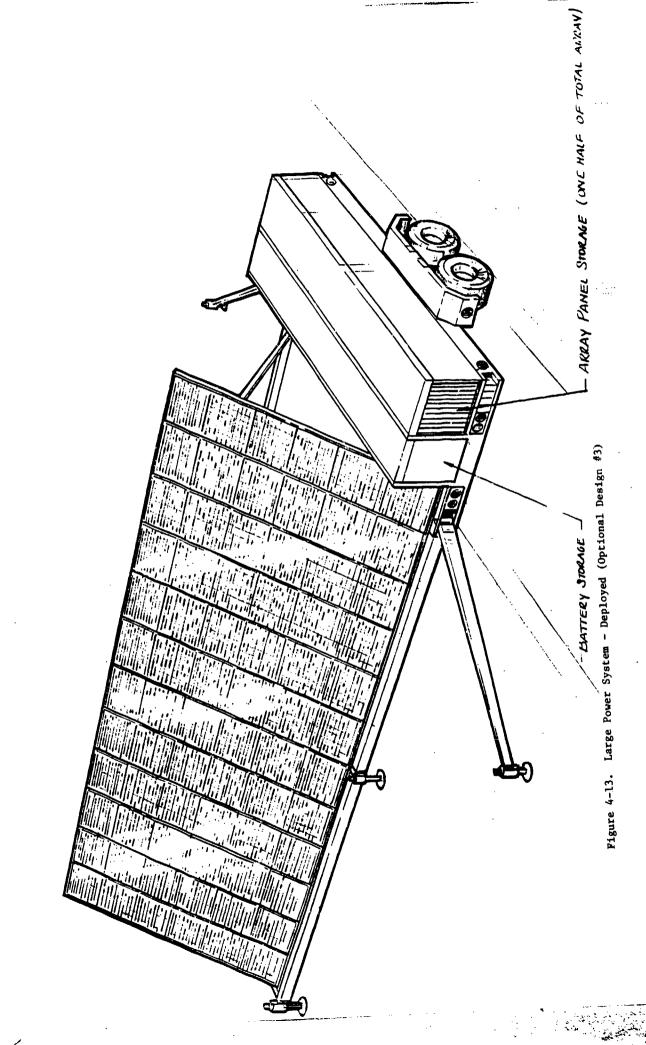


Figure 4-14

Ranking of Various Design Concepts

	Figure No. 4-1.		l Trailer) 4-7/10			arge Trailer) 12 4-13
Transportable	1	ı	1	1	1	1
Tiltability	1	1	1	1	1	1
Foldable	1	1	1	2	3	2
Withstand Environme	ents 1	1	1	1	1	1
Separable to aid camoflaging	1.	1	1	2	2	2
Light Weight	1	2	1	ı	4	3
Compact When Folded	i 1	1	1	1	1	ı
Withstand Field Har	ndling l	1	1	1	1	1
Low Cost	1	1	1	1	1	1
Comment	С	В	A	F	D	E
Overall	1	2	3	1	3	2

Note: Ranking based on rating of 1 to 4 with 1 being the highest.

Comments:

- A. Structure not integrated with module. Telescoping arms can bind.
- B. Telescoping arms can bind. Stakes to ground.
- C. Can be rotated after erection.
- D. Many separate parts. Wide array (8' x 72' versus 12' x 48'). More outriggers.
- E. Greater force to raise panel. Sliding arms can bind. Position of toe rail results in heavier panel side channel, but many features of this design would be incorporated into the final design.
- F. Few parts, all large.

per pound to estimate the total structure cost. 6061 aluminum was selected because it can be most easily welded and extruded. Higher-strength aluminums, such as 2024 and 7075, are available at somewhat higher costs and are considerably more difficult to fabricate. However, if the design is to be pursued toward construction some of the alternate materials should be more closely evaluated. Their use could reduce the structure weight by 50 percent and hence improve photovoltaic performance by allowing larger total array and battery capacity.

The structure for the battery housing was also analyzed and the trailer beds were found to provide sufficient support when constructed of channels and solid flooring. Therefore, no additional work was necessary in this regard. A fiber-glass-reinforced plastic cover would be placed over the batteries for protection from the weather as well as for safety.

Finally, two designs were distilled from the range of features advanced in the preliminary conceptual design phase. Their descriptions and some details regarding their operation follow.

Description of the Recommended Designs

1. Small Trailer Size Transportable PV System

This smaller system is designed to carry a 5 m^2 array (Figure 4-5) and be towable by an M 141 truck when the system is stored.

The smaller trailer would have the batteries located down the center line of the trailer with the photovoltaic modules stored on edge, on both sides of the batteries, extending four feet front to back and two feet high in the stored position. A canvas or fiberglass cover protects the equipment from the weather. The batteries are accessible from the ends of the trailer even when the panels are stored or, for easier access, one of the photovoltaic panels may be swung away.

The modules are each two feet by four feet, with the twofoot edge resting horizontally when erected.

To erect the array, one of the two 120-pound panels containing three modules is tilted upward, while still folded, pivoting on a hinge attached to the trailer bed. The folded array is then rotated around a vertical axis so the first module is facing the sun. Hinges between the modules then permit unfolding of the panel with its four-foot edge still vertical so that all three modules face the sun. Bars are

rotated, to lock the modules and prevent rotation around the hinges after erection. Three back braces are attached to the structural channels at the rear of the modules with a rotating key in order to lock the brace and the panel structure together. While one man holds the array, tilting it slowly to the optimal angle, the other attaches the braces to an eye on the trailer. The maximum force that need be extended by each man would te 65 lbs.

Jacks are then extended from the four corners of the trailer to stabilize the system. The jacks are staked into the ground with two or three stakes, depending on the wind speed and the stiffness of the soil. By driving the stakes at an angle of 45 degrees from the vertical, approximately 1,000 pounds withdrawal force can be achieved at each jack. For 60-knot winds, additional staking is required at the tongue. However, no staking at all is required at winds below approximately 30 knots.

One note of interest is that the small sized array can deliver perhaps twice as much power per square foot as a larger array if the vehicle is manually rotated to more directly face the sun throughout the day. Only four rotations would be required daily and the structure has been designed so that all of the supports are on the trailer to facilitate rotation. Since staking of the jacks is only required in high

winds, re-orientation is not difficult under most operating circumstances.

2. Large Trailer Size Photovoltaic Transportable Systems

In spite of its much larger size, the 60-square meter (36' long by 12' high) array designed for towing by the 2.5-ton army truck is designed for erection by two men in less than two hours.

The photovoltaic panels are stored on edge along the 12 foot length of the trailer rising only two feet high. As in the small trailer, the batteries are located along the centerline. The batteries in this case, however, are accessible from a walkway between the panels and the batteries. In addition, one set of 12 panels may be removed for easier access. A canvas or fiberglass cover protects the power system.

The array erection process begins with two men installing the supporting structure. First, two 18 foot rails are extended from each side. These rotate or telescope into position. Two open-web trusses per side are next installed by latching them to the rails and staking them to the ground. On windless days, only two stakes are required but in 60-knot winds six stakes are required per truss. The men then each

grab one end of a 12 foot by 2 foot 125-pound panel and carry it into a horizontal position on the rails. When in position, the panel is slid toward the rear of the rail and catches in a keyway. After all of the panels are resting on the rails, the men go to the north side, where each man lifts one panel, grabs the rear support rod and push the rod until the panel is at the desired tilt. The rod is then inserted into an eye on the north rail and becomes part of the structure. The installation is complete once the panels are all at the desired tilt. No bolts or pins are required.

The structure was designed to be fabricated from 6061 aluminum, which costs approximately \$2.50 per pound in small lots for extrusions. Therefore the cost of the structure as designed is approximately \$5.00 per square foot of array or 50¢/watt. If 2024 aluminum were used instead, the cost would be higher on a weight basis due both to higher material costs and higher fabrication cost. On the other hand the weight could be reduced by as much as 30 to 50 percent. Since the total weight of the 6061 system is 860 pounds, this would result in as little as 430 pounds for the 2024 structure. The same structura1/mechanical concept could be used with the small trailer to increase the array size to 13 square meters.

SECTION 5

LIFE-CYCLE COST ANALYSIS

5.1 Methodology

At the core of the analysis presented in this section is the concept of the life-cycle cost of a system (LCC), defined as "the present value, as of a specified time period, of all the cash outflows required for constructing and operating (inclusive of maintenance) a system over its lifetime." The categories employed in this analysis are: 1) Operations and Maintenance Costs (O & M), which include expenditures for labor and materials required for supervision, operation, and maintenance (exclusive of major capital replacement; and 2) Capital Costs (CI), which include expenditures for equipment, labor and materials required for construction and major capital replacement. "Nonroutine", or major maintenance is treated as capital replacement and included under capital costs.

Table 5-1 presents a cost breakdown of the components used in this life-cycle analysis. The following determinants were used to compute these costs:

- The array cost per peak watt output is based on projected cost reduction goals by the Department of Energy for the production of photovoltaic arrays. It assumes peak insolation of 1,000 w/m² at 10 percent collector efficiency, with a result of 100 Wp/m².
- 2. The array structure, as indicated in Section 4, will be built entirely cut of aluminum. The cost is based on the use of two pounds of aluminum for each square foot of array, with a cost of \$2.50 per pound.
- 3. The trailer costs are based on detailed estimates supplied by a trailer manufacturer. The trailer costs are for customized equipment conforming to all applicable standards, and thus may be higher than could be expected for modification of existing designs or large-scale production.
- 4. The battery costs are based on a survey of current battery costs. These costs assume the utilization of high-quality lead-calcium batteries, with a 50 percent rate of discharge, and a useful lifetime of ten years. Based on industry projections and current research in battery materials, a price reduc-

tion is projected during the late 1980's. All battery replacements are assumed to be at this lower price.

- 5. Power conditioning costs are based on a survey of equipment manufacturers. The declining cost estimates are projected to result from standardization, and technological development. This cost estimate includes the cost of control apparatus and wiring. Replacement costs are assumed to be at \$0.20/Wp. Equipment lifetime, based on manufacturer's estimates is ten years.
- 6. O & M costs are based on computer cost runs and actual operating data. Installation costs are included in these estimates.
- 7. In accordance with federal guidelines for equipment purchases, the discount rate used in this analysis is ten percent. Based on short run inflation rate projections by several private forecasting firms, and long-run projections by federal agencies, the inflation rate used was seven percent. The O & M present value multiplier was determined from these parameters.

Table 5-1

Component Cost Breakdown

					i
Component	(1)	(2)	(3)	(4)	(5)
Array	\$15/Wp	\$10/Wp	\$5/Wp	\$2/Wp	\$1/Wp
2 lb/ft ² aluminum \$10/ft ² Array Structure (10.76 ft ² /m ²)	.54/watt	.54/watt	.54/watt	.54/watt	.54/watt
Trailer a) b)	12,590 6,295	12,590 6,295	12,590 6,295	12,590 6,295	12,590 6,295
Battery (50% discharge: 2 x Wp) \$75/kWh	\$150/kWh	\$150/kWh	\$150/kWh	\$75/kWh	
Power Conditioner	0.5/WP	0.4/Wp	0.35/Wp	0.20/Wp	
0 & M (pv)*	u.zu/wp 1% array + 1% structure conditioner	15.15 ×	trailer +	2% batteri¢3 +	3% power
CPF = .1174596 (E9) $CI = \frac{1}{1} + \frac{9}{1}$					
*Assumeb k = 10%, g = 7%, syst Note: DOE Cost Goals - \$/watt	= 7%, system life: 1982 18 - \$/watt \$2.80	stem lifetime 20 years. 1982 1983 1984 1tt \$2.80 \$2.30 \$1.75	1985 1986 \$1.25 \$.70		

The following calculations were used in the life cycle cost evaluation of the photovoltaic system:

1. The present value of the replacement cost of the batteries and power conditioning was determined by:

$$(1 + g) \left[CI \quad \star \quad \left(\frac{1 + g}{1 + k} \right)^{j} \right]$$

2. Capital costs (CI_{pv}) were calculated by using:

$$\operatorname{cr}_{\operatorname{pv}} = (1+g)^{\operatorname{p}} \sum \left[\operatorname{cr}_{\operatorname{t}} \left(\frac{1+g}{1+k} \right)^{\operatorname{j}} \right]$$

- 3. O & M costs were calculated by using the present value multiplier.
- 4. The capital recovery factor was calculated by:

$$CRF = \frac{k}{1 - (1+k)^{-n}} = .1174596$$

5. The annualized system cost (\overline{AC}) was computed by:

$$\overline{AC} = (1+g)^{-d} \left\{ CRF \left[(0 \& M)_{pv} + CI_{pv} \right] \right\} = 0.12568 \left[(0\&M)_{pv} + CI_{pv} \right]$$

6. The annual energy output of the photovoltaic system was determined as:

$$E_A = (% Duty) (Load) (Availability) \times (\frac{24 \text{ hr}}{\text{day}}) (\frac{365 \text{ days}}{\text{year}})$$

7. The levelized energy cost was determined by using:

$$E_L = \overline{AC}$$

where:

- Yp The price year, or the reference year for prices for which the best cost data is available
- Y_{O} The year of first operation for the system
- Y_t The year for a particular expenditure.
- k = The opportunity cost of money
- CI₊ = Capital investment in year 't"
- $p = Y_0 Y_p$
- $j = Y_t Y_0 + 1$
- $d = Y_0 Y_p$
- g = General rate of inflation
- CI_{DV} = Present value of capital costs
- O & Mov = Present value of operation + maintenance cost

5.2 Conclusions

Table 5-2 and 5-3 show the total and annualized system costs for each cost schedule and for each array on the small and large trailers. They indicate that current system costs decrease dramatically over the next several years - thru 1986. For perspective, cost schedule (1) represents current system costs while the component costs reflected in schedule (5) are projected to be reached by 1986. The total cost of the 60 m² array decreases from \$137,342 initially, to \$34,089 in schedule (5). Similarly, the cost of the 3.5 m² array drops from \$17,108 to \$10,240.

The annualized cost of the 60 m^2 array decreases to \$4,595 from an initial \$17,571. Figure 5-1 illustrates these annualized cost reductions. These calculations may be slightly high due to several factors which will be discussed later.

Tables 5-4 and 5-5 show the total annual energy output of each system, for each of ten selected cities, for loads of 250, 500 and 1,000 watts and duty factors of 25, 50, 75 and 100 percent. Table 5-6 indicates levelized energy costs for 40 m^2 and 60 m^2 arrays. Figures 5-2 (a - d) indicates these costs graphically. It is evident from Table 5-4 that the 5 m^2 array

is not reliable for any of the selected locations. this array does not provide any significant power on a dependable basis, there appears to be little justification for calculating the energy costs of this system. It should be noteo that the duty factors represent the percentage of a time period during which the system is being utilized. Since this is a transportable system, it is highly unlikely that the system would be utilized 100 percent, 75 percent, 50 percent and possibly even 25 percent of the time on an annual basis. While this assumption increases the energy cost for the systems, there is a tradeoff of lower loss of load probabilities on an annual average.

These energy costs are higher than normal for several reasons. First, the energy output measured in Table 5-3 is much lower than maximum potential energy. This results from limitations imposed by the load, duty factor, and storage capacity.

A second reason that these costs may be high results from the assumption of 10 percent collector efficiency. While this estimate is reasonable, if not conservative with current output technology, it is a low estimate for future efficiencies. Industry projections indicate that average efficiencies of 12 percent can be expected in the near term with efficiencies of up to 20 percent within the next decade. Even the two percent

Table 5-2
Annualized System Costs
Small Trailer

(5) 5 m ² 500 540 6,295	100	592 1,384 10,240 2,991 1,287	
(4) 5 m ² 1,000 540 6,295	100	592 1,460 10,816 3,567 1,359	
(3) 5 m ² 2,500 540 6,295 1,500	175 79	592 1,948 13,629 6,380 1,713	
(2) 5 m ² 5,000 540 6,295 1,500	200	592 2,338 16,544 9,295 2,079 1,168	
(1) 5 m ² 7,500 540 6,295	250	592 2,726 19,496 12,247 2,450	
Cost Schedule (From Table 5-1) Array Structure Trailer Battery	(10 kWh/5 m ²); 12 kWH/3.5 m ²) Power Conditioning	Battery Replacement _{pv} (O & M) pv Total (T) pv Total (W/o trailer) Annualized System Cost	

Note: All figures are in 1980 dollars.

Table 5-3
Annualized System Costs
Large Trailer

Cost Schedule	(1)		(3)		(3)		(4)		(5)	_
(From Table 6-1)	60 m ²	40 m ²								
Array	90,000	60,000	60,000	40,000	30,000	20,000	12,000	8,000	6,000	4,000
Structure	6,456	4,304	6,456	4,304	6,456	4,304	6,456	4,304	6,456	4,304
Trailer	12,590	12,590	12,590	12,590	12,590	12,590	12,590	12,590	12,590	12,590
Battery 2 , (40 kWh/60 m^2) , $70 \text{ kWh/40 m}^2)$,00°9	10,500	6,000	10,500	6,000	10,500	3,000	5,250	3,000	5,250
Power Conditioner	3,000	2,000	2,400	1,600	2,100	1,400	1,200	888	1,200	800
P.C. Replace,,*	947	632	947	632	947	632	947	632	947	632
by Battery Replace _{pv}	2,368	4,144	2,368	4,144	2,368	4,144	2,368	4,144	2,368	4,144
O & M (15.15 govt. multiplier)	19,212	15,740	14,395	12,528	9,713	9,407	5,668	5,726	4,759	5,120
Total _{ov} (T)	139,811	109,910	104,394	86,298	69,412	62,977	43,467	41,446	36,558	36,840
(w/o trailer)	125,314	95,413	89,897	71,801	54,915	48,480	28,970	26,949	22,061	22,343
Annualized System Cost										
AC = .12568 (T) {w/o trailer}	17,571	13,813	13,120	10,846 9,024	8,724	7,915	5,463	5,209	2,773	4,630

Note: All figures are 1980 dollars.

Annual Erergy Output (kWh) Location, Duty Factor/Large Trailer

Location	Load (kW)	40 m ²	25% 60	m ²	40 m ² 50%	% 60 m ²	40 m ² 7!	75% 60 m ²	40 m ² 100%	0% 60 m ²
Washington, D.C.	.250 .500 1.000	548 1,095 2,096	1,0 2,1	547 095 130	1,095 2,190	1,095 2,178 3,220	1,643	1,641 2,904 2,539	2,096	2,178 3,110 372
San Antonίο, Texes	.25 .50 1.0	548 1,095 2,190	1,0 2,1	548 095 190	1,095 2,190	1,095 2,190 4,292	1,642 3,249	1,642 3,281 4,130	2,190	2,190 4,295 2,457
Juneau, Alaska	0.25 0.50 1.0	203	5 9 1,3	527 970 340	111	970 1,340 1,476	111	1,178 1,481 78	111	1,340
Cambridge, U.K.	.25 .50 1.0	548 992 -	1,0	547 067 567	266	1,067 1,567 1,863	.1 1 1	1,379 1,900 1,108	111	1,567
Almeria, Spain	0.25 0.50 1.0	548 1,095 2,190	1,0 2,1	548 095 189	1,095 2,190	1,095 2,189 4,318	1,642	1,642 3,282 4,650	2,190	2,190 4,318 3,532
Albrook AB Panama	.25 .50 1.0	548 1,095 2,190	1,0 2,1	548 095 190	1,095 2,190	1,095 2,190 4,334	1,642 3,278	1,642 3,281 3,227	2,190	2,190 4,334 590
Seoul, Korea	. 25 . 50 1. 0	548 1,095 2,190	1,0 2,1	548 095 196	1,095	1,095 2,190 4,209	1,642 3,095	1,642 3,277 2,935	9,190	2,190
Jerusalem, Israel	.25 .50 1.0	548 1,095 2,190	1,0 2,1	548 095 190	1,095 2,190 4,354	1,095 2,190 4,379	1,642	1,642 3,285 6,187	2,190	2,190 4,379 5,528
Honolulu, Kawaii	.25 .50 1.0	548 1,095 2,190	5 1,0 2,1	548 ,095	1,095 2,190 3,797	1,095 2,190 4,374	1,643	1,643 3,285 5,014	3,797	2,190 4,374 2,485
Munich, W. Germany	. 25 . 50 1. 0	547 1,075 1,822	1,0 1,8	547 1,090 1,882	1,075	1,090 1,882 2,575	1,368	1,496 2,669 2,220	1,822	1,882

Table 5-5
Annual Energy Output (kWh) By Location, Duty Factor/Small Trailer

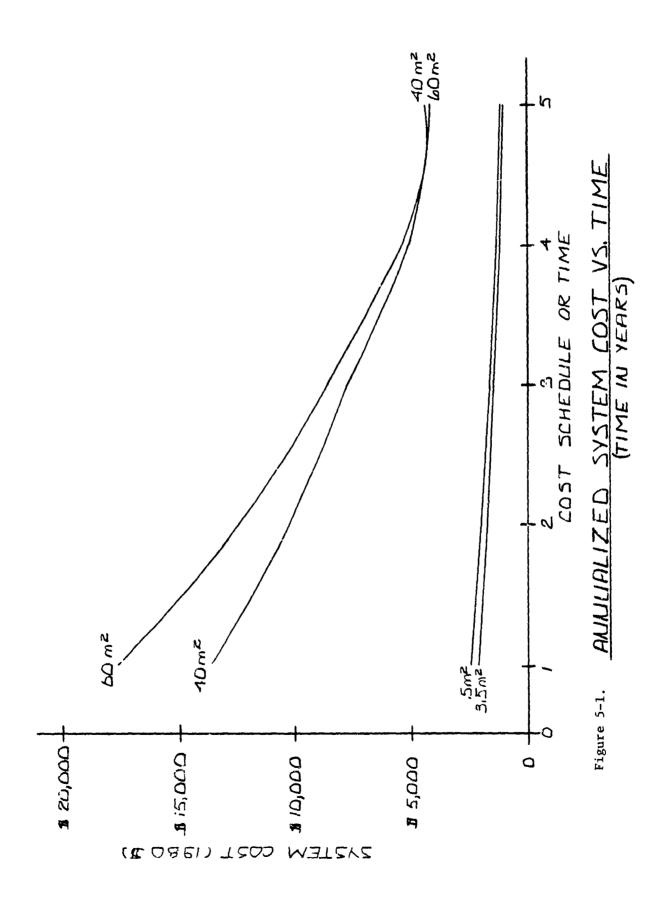
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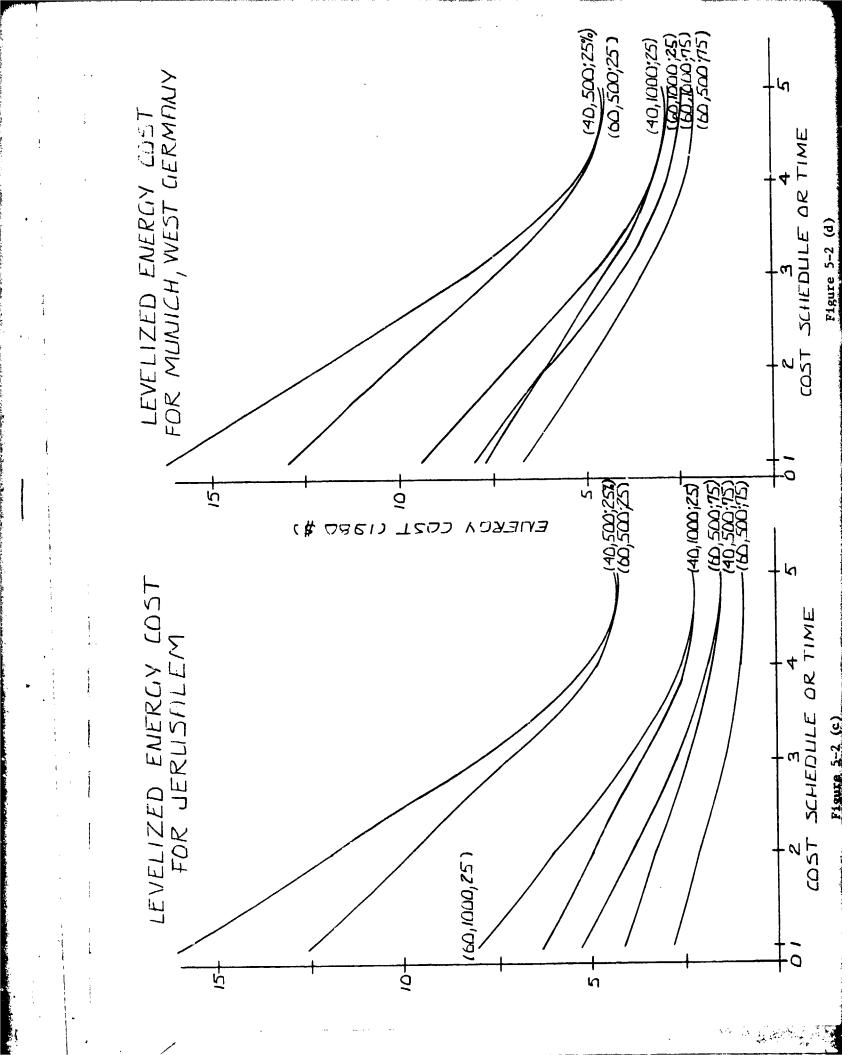
I lead number, ity of greater than 20%.

Table 5-6 Levelized Energy Costs (5) for 40 m² and 60 m² Arrays

			(1) 25%	75%	(2) 25%	75%	75%	(3) 75%	, see 1	(4) 75%	25%	(5)
	200	40 m ² 60 m ²	\$ 12.61 16.05	\$ 5.40 5.36	9.90 11.98	4.24	7.23	3.09	4.76	2.04	4.23	1.81
San Antonic, Texas*	1,000	40 m ² 60 m ²	6.30	4.25	4.95 5.99	3.17	3.61	2.11	2.38	1.32	2.11	1.11
	200	40 m ² 60 m ²	18.11	11.86	13.52	8.86	8.99	5.89	5.63	3.67	4.74	3.10
Juneau, Alaska	1,000	40 m ² 60 m ²	13.11	225.26	9.79	168.19	6.51	111.84	4.07	70.03	3.43	58.90
	200	40 m ² 60 m ²	12.61 16.05	4.20	9.90	3.30	7.23	2.41	4.76	1.58	4.23	1.41
Jerusalem, Israel	1,000	40 m ² 60 m ²	6.31 8.02	2.84	4.95 5.99	2.12	3.62	1.41	2.49	0.88	2.12 2.10	0.74
	200	40 m ² 60 m ²	12.85 16.12	6.58	10.09 12.04	4.91	7.36	3.27	4.85	2.05	4.31	1.72
Munich, W. Germany	1,000	40 m ² 60 m ²	7.58	7.91	5.95 6.97	5.91	4.34	3.93	2.86	2.46	2.54	2.07

*Energy costs for Washington, D.C. Almeria, Spain, Albrook AB, Panama, Seoul, Korea, Honolulu, Hawaii are similar to these costs.





difference from 10 percent to 12 percent would result in a 20 percent increase in projected output; a significant variation.

Third, it is important to note the significant contribution of initial trailer costs and trailer 0 & M costs to the total and annualized system costs. Because the photovoltaic system is not designed to be removable under normal operating conditions, the cost of the trailer was assumed to be a system cost. But because it is a fixed cost over time, while the costs of the other major components decrease, the trailer cost and 0 & M costs assume a larger portion of total costs over time. For example, trailer costs for the 60 m² array increase from nine percent to 40 percent of total system costs. Table 5-7 shows trailer costs as a proportion of total costs, and presents the annualized system costs with the trailer excluded. Figure 5-3 graphically illustrates the trailer costs as a percentage of total costs.

Because the trailer costs are such a large portion of the system cost, especially in later years, the energy cost does not drop as significantly as it would if the trailer were not considered part of the system. Table 5-8 shows the energy cost with and without trailer inclusion in system costs for a selected location on a 500 watt load for a duty factor of 75 percent. Figure 5-4 illustrates the lowering of energy cost which results from trailer exclusion.

<u>Table 5-7</u>
<u>Effect of Trailer Cost on Levelized Energy</u>
Cost for 500 Watt Load at 75% Duty Factor

_	t Schedule					
Arre	ay Size m ²	(1)	(2)	(3)	(4)	(5)
San Anto	onio					
40	w/trailer	5.40	4.24	3.09	2.04	1.81
	w/o trailer	4.70	3.52	2.38	1.33	1.10
60	w/trailer	5.36	4.00	2.66	1.67	1.40
	w/o trailer	4.88	3.44	2.10	1.12	0.84
Je ₁ usale	m					
40	w/trailer	4.20	3.30	2.41	1.50	1.41
	w/o trailer	3.65	2.74	1.86	1.03	0.86
60	w/trailer	5.35	3.99	2.66	1.66	1.40
	w/o trailer	4.87	3.43	2.10	1.11	0.84

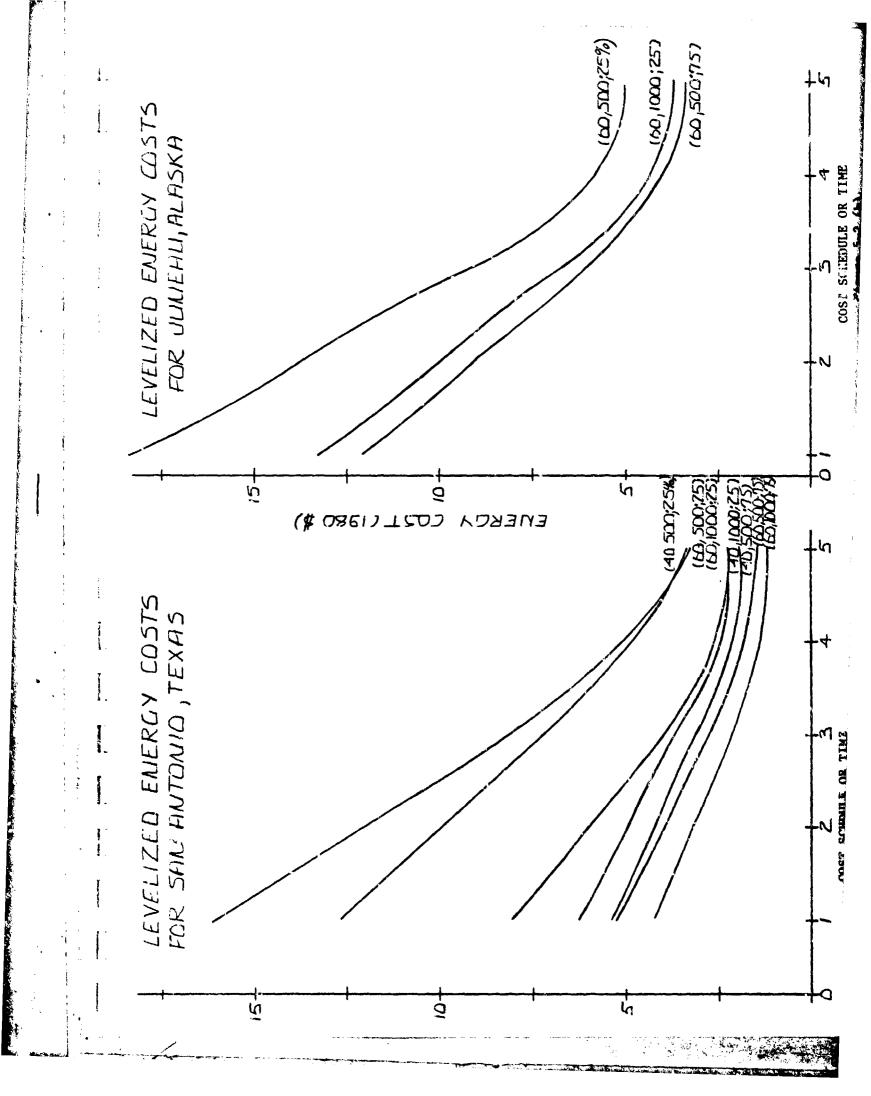


Table 5-7
Comparison of Annualized System Costs
With and Without Trailer Costs
(1980 Dollars)

Cost Schedule					
Array Size m ²	(1)	(2)	(3)	(4)	(5)
60 m ²					•
AC (w/trailer)	17,200	12,749	8,352	5,092	4,223
AC (w/o trailer)	15,378	10,972	6,535	3,270	2,401
Trailer as % Total Costs	98	13%	19%	32%	38%
40 m ²					
AC (w/trailer)	13,540	10,573	7,642	5,936	4,357
AC (w/o trailer)	11,718	8,750	5,820	3,114	2,535
Trailer as % Total Costs	12%	15%	21%	32%	36%
5 m ²					
AC (w/trailer)	2,416	2,045	1,679	1,325	1,253
AC (w/o trailer)	1,505	1,134	768	414	342
Trailer as % Total Costs	38%	45%	54%	69%	73%
3.5 m ²					den de
AC (w/trailer)	2,126	1,865	1,609	1,300	1,249
AC (w/o trail(r)	1,214	954	698	389	340
Trailer as % Total Costs	43%	49%	57%	70%	73%

Table 5-8

Comparison of Annualized System Costs

With and Without Trailer Costs

Cost Schedule	\$15/Wp	\$10/Wp	\$5/Wp	\$2/Wp	\$1/Wp
Array Size m ²	(1)	(2)	(3)	(4)	(5)
60 m ²					
AC (w/trailer)	17,571	13,120	8,724	5,463	4,595
AC (w/o trailer)	15,749	11,298	6,902	3,641	2,773
Trailer as % Total Costs	9%	14%	21%	33%	40%
40 m ²					
AC (w/trailer)	13,813	10,846	7,915	5,209	4,630
AC (w/o trailer)	11,992	9,024	6,093	3,387	2,808
Trailer as % Total Costs	13%	17%	23%	35%	39%
5 m ²					
AC (w/trailer)	2,450	2,079	1,713	1,359	1,287
AC (w/o trailer)	1,539	1,168	802	448	376
Trailer as % Total Costs	37%	44%	53%	67%	718

As a result of these factors, the systems energy costs are substantially greater than if these factors were excluded from the analysis. There is debate as to whether or not these factors should be considered in the overall analysis, but they have been included so as to present the most conservative cost estimates. Their effect should be noted in any cost effectiveness considerations.

From the data presented in this section several broad conclusions concerning the costs for the different systems can be reached:

- 1. The small trailer arrays, 3.5 and 5 square meter, do not generate sufficient energy or maintain sufficient availability to be economical and reliable power systems.
- 2. There are several locations (Cambridge, U.K., Juneau, Alaska) where the systems maintain high energy costs throughout the cost reduction schedule. Coupled with high LOLP, in these locations, the solar power system does not appear to be economical or practical power systems.
- 3. In contrast to the locations mentioned above, a number of locations exhibit reasonable energy

costs, especially with the projected system cost reductions.

- 4. Overall the smaller array is the least expensive system initially, due to the relative expense of larger arrays size versus larger battery capacity. But as the array cost decreases, the 60 m² array becomes more economical than the 40 m² array. The trend in cost reductions indicates over the long run the larger array would be less expensive per energy output.
- 5. In all locations, the larger array is both more reliable (lower LOLP) and, in the long run, less expensive per energy output. Since the smaller trailer arrays appear inadequate to carry a significant load, the large array with moderate storage capacity appears to be the most cost effective solar energy system.

SECTION 6

TRANSPORTABLE PHOTOVOLTAIC SYSTEM CHARACTERISTICS

In this section, the results of the sizing analysis described in Section 5 are presented, as well as an understanding of how to interpret the performance charts for the separate locations and individual trailers.

As described in Section 4 the objective in presenting this information was to provide the basis for decisions concerning which system to use for a given location and load. For this reason charts have been presented at the end of this section which summarize performance characteristics (availability) as a function of load, duty cycle and trailer size for ten representative locations. Data in these charts is based on the assumption that the trailer is oriented to the equator and tilted to the appropriate latitude. Improvement may be realized by optimizing both tilt and orientation with respect to the daily and seasonal position of the sun.

6.1 Use of the Performance Charts

The charts at the end of this section present the loss-

of-load-probability and availability for three trailer systems at ten locations under a variety of load conditions. The charts are presented in order of best performance first and worst last, by location. The ranking is the same as presented in Section 3.

These Section 6 charts present only data for applications where availability is greater than or equal to 80 percent. When availability drops below 80 percent a dashed line masks the data and when the system is simply too small to meet the load at all then "N/A" is inserted.

Four major columns represent the load in watts with four minor columns under each of these representing the percentage of 24 hours the load is supplied. The rows of the chart present the loss-of-load-probability and availability for each of the trailers. Two charts for each location present a total of five possible array, battery and trailer combinations. LOLP and availability are first given on an average annual basis but this alone is not enough to give a feeling for the application on a seasonal basis. For this reason minimum and maximum LOLP's are also provided in the last two rows of each trailer's data, minimum and maximum refer to the smallest and largest LOLP occurring during any month of the year.

In Honolulu, Hawaii, for example, the number one small trailer, when used with a 250 watt load supplied 25 percent of

the time will be available 88.1 percent of the time (LOLP = 11.9 percent) on an annual basis. Referring to the min/max rows, however, one sees that the LOLP ranges from 0 to 100 percent. For more detailed information the user must refer to the Appendix of this report where the complete computer output is presented on a monthly basis and interpret the appropriate chart as it is explained there. Doing so for the given trailers and load in Honolulu reveals that December availabílity drops to 0% and January just exceeds 60 percent, but all other months exceed 95 percent availability.

If then the range of LOLP extremes on the condensed chart exceeds acceptable limits for the user, then the user must interpret the more detailed data to determine whether or not the time of year for intended use is prohibitive.

An example of a case not requiring use of the Appendix charts would be in the chart for Jerusalem, Israel, the best location presented. Looking at the large trailer for a 1,000 watt load used 50 percent of the time reveals that availability averages 99.4 percent year round. The range of LOLP is from 0 to 7.5 percent (availability = 92.5 to 100 percent). Providing that a 7.5 percent is not unacceptable, the large trailer could be selected for this application with no further examination.

Presented in this way the decision to deploy a photovoltaic power system trailer requires only four inputs:

- o The location of interest
- o The load size in watts
- o The percentage duty for the load in 24 hours on an average
- o The maximum acceptable LOLP

Beginning with the selection of location a chart is selected at or near the proposed site. More charts may be generated for any location for which meterological data is available, including more than 200 sites worldwide. appropriate chart from Section 6, the load size and the duty factor beneath it which most nearly corresponds to the percentage use are selected. Reading down this column the decision maker checks the overall availability of each trailer. For those which meet their acceptability criteria, they must check the min/max range of LOLP and see if it is also acceptable (referring to Appendix A if necessary). Of those trailers which meet the performance criteria, one may wish to select the smallest for ease of transportation or perhaps a larger trailer if multiple destinations are planned where other loads or conditions prevail. This decision is strictly a logistic one depending on other parameters as well as performance.

System economics may be a governing factor if a decision is being made between a photovoltaic system and a diesel generator set, for example. In this situation, reference to Sections 2 and 5 of this report will help to clarify this In cases where the small trailer is feasible (for example with smaller loads) the busbar energy costs may be considerably lower than for an under-utilized large trailer.

On the other hand, perhaps the difference in availability may be between 90 and 95 percent for a small and a large trailer. A look at the energy costs for the two options will reveal the marginal costs for that extra five percent availability with the large trailer. That cost may frequently be found to be quite high.

For many applications, especially temporary ones, energy cost analysis will not be pertinent when taken as a busbar cost over a full years' operation. More important will be the capital cost of alternatives and the comparative reliability of alternate systems.

6.2 A General Overview of Systems and Applications

As was briefly mentioned in Section 3, it is noteworthy that a distinction forms between insolation in regions 53

approaching the equator and regions approaching the poles. The regions about 40° latitude seem to degenerate uniformly in insolation levels with increasing latitude largely independent of site specific variations. Below 40° latitude performance seems more highly site specific. Local conditions such as smog, of course, alter this conclusion. It is important also to note that the higher latitudes experience wider discrepancies in performance than do the lower ones.

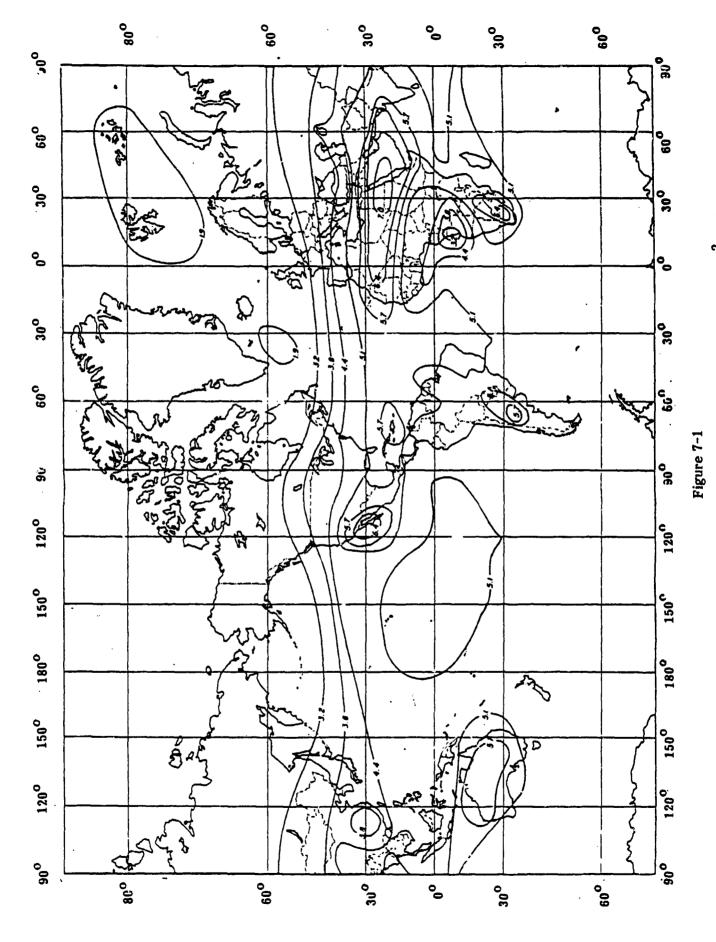
If these tendencies hold true over the sites of interest then the following two decision strategies are suggested. First, in higher latitudes, a trailer which will serve a load in one location will very likely serve the same load in another location at the same or proximate latitude because performance here is dependent heavily on latitude. Progressively larger photovoltaic systems are required as latitude increases.

Secondly, in regions below 40° and especially below 30°, although performance is considerably more dependent on sites than latitude, the performance between one site and another does not vary that dramatically becaus insolation is generally high. This suggests that a trailer deployed in an equatorial or sub-tropical region would also have a wide range of applications in other adjacent regions, not only going east and west as before, but also covering quite a range of latitudes north and south.

A look at worldwide insolation maps tends to bear these conclusions out in a general sense. The isolines of constant solar insolation tend to be fairly smooth east to west in latitudes above 40° . Below 30° however, they tend to form in more isolated circular patterns but the intensity remains very high throughout the gradient. See Figure 6-1.

Another more striking conclusion brought out by the results of the computer simulation is the surprisingly limited utility of a small trailer loaded with photovoltaic array and battery. Even in Jerusalem where conditions were the best, the smallest trailer (3.5 m² array and 6 kWh battery) served only the smallest load (125 W) and smallest duty cycle (25 percent) with better than an 80 percent availability. The next largest trailer with 5.0 meters of array improved performance by 43 percent but still only served 250 watts 25 percent of the time.

As previously stated, the sizing of array and battery was based on trailer capacity primarily. Even though these physical constraints exist, analysis was performed of a small trailer with 13 m² array and 5 kWh of battery storage. This resulted in a performance improvement of 172 percent over the 5 m² array and 290 percent over the 3.5 m² array, making it possible in Jerusalem, at least, to run loads of 500 W up to 25 percent of the time. Even in Munich, this configuration would



AVERAGE ANNUAL DISTRIBUTION OF SOLAR RADIATION (KWh/m 2 day)

manage 250 W at 25 percent duty cycle with 83 percent availability.

Because of the large array area of a 13 m² array on the small trailers extreme measures would have to be taken to eliminate the sail effect in strong winds if such a trailer were to be made. This could entail extra long outriggers, extensive guy wires and reinforced panel structure. Set up also would be more time consuming.

All of this effort would increase the size and weight of the smaller trailer and still only serve a load of a few hundred watts at most.

Certainly some electrical needs can be served at these levels, but the demand for those small loads must certainly be considered in deciding whether to produce such a small system in addition to the larger one.

Conclusion:

If sufficient demand exists for exclusively small loads or very small duty cycles, then a small trailer can certainly provide an economic option. If on the other hand demand is small or occasional for small loads, perhaps only the larger trailer will prove economic. Again, reference to the energy cost analysis of Section 5 will prove helpful in this case.

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: 110ATC	į	(TTS)	25		0.0 0.0 0.0 0.0 100.0 100.0 100.0 100.0	LOAD E	0.0		0.001	LOAP E	0.0		0.001	OF 10AD EXTREHES 0.0 0.0	TRAILER TRAILER
LOCATION : HONOLUEU, HAWAII		LOAD (WATTS)	* DUTY	LRG TRAILER	LOLP	TOSS OF LOAD EXTREMES	HAX	SM 1 TRAILER	LOLP	LOSS OF LOAD EXTREMES	MAX	SH 2 TRAILER	LOLP	LOSS OF MAX III N	LRG TRAILER SH 1 TRAILER
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LOCATION : HONOLULU, HAWAII

	2000	25 50 75		0.1 N/A 99.9 N/A	0.6 H/A		N/N N/N N/N
		75 100		!!			N/N N/N
	1000	50 75		99.9	9.0		Y/N
BATTERY SIZE (WWh) : 20.0 Rattery Size (WWh) : 5.0		25		0.001	0.0		X 2
(KAP)		100		9.65	9.0		4/H
17 S12F	200	15		100.0	0.0		× × ×
RATTER		0:0		100.0 0.0	0.0		X X
13.0		25		100.0	0.0		9.66
ARRAY (SO. METERS) : 60.0 ARRAY (SO. METERS) : 13.0		100		0.0	0.0		< < <
(50. N	250	50 75		0.001	0.0 0.0		
ARRAY ARRAY				0.0 0.0 0.0 0.0 100.0 100.0 100.0 100.0	EXTREM! 0.0 0.0		9.66
ILER J	ATTS)	25		100.0	0.0 0.0		0.0 0.4
IG. TRAILER SK. TRAILER	LUAD (WATTS)	• DUTY	LG. Trailer	LOLP	LOSS OF LOAD EXTREMES MAX 0.0 0.0 0.0 MIN 0.0 0.0 0.0	SH. TRAILER	LOLP

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3.	20				0.0	H/A	Š.	N/N N/N	#/H	4/H	X X	
	25		6.6	100.0 100.0	0.0	۲ <u>۷</u>	N/N	A/8 A/51	4/2	K/X	H/H H/A	. 35.0 . 5.0 . 6.0
	901	}	c.	0.00	0.0	2	K / X	4 × ×	<u> </u>	H/A	X Z X X X X X X X X X X X X X X X X X X	NATTERY SIZE (KWh) RATTERY SIZE (KWh) NATTERY SIZE (KWh)
5		2	c	100.0 100.0 100.0 100.0	0.0	2	¥	K < K		1 × ×	X X	CRY SIT
. e.		ŝ	•	. 6. 60	e.c.	;	Z Z	4 × ×	;	* * * * * * * * * * * * * * * * * * *	N X X	TAN TAN
UDE :	ļ	5 2	•	100.001	0.0		1 1				; ;	40.0 5.0 3.5
LATITUDE :		100			0.0		× × × × × × × × × × × × × × × × × × ×	N/N 11/A		× < <	K K K	(SQ. METERS) : (SQ. METERS) : (SQ. METERS) :
, PAH	2	75		0.0	9.0		X X	4 4 2 2		* * X	S X/X	(50. 1
OK A B	125	20		0.0	TREMES 0.0 0.0		11	(TREMES		1 1	XTRENE	ARRAY ARRAY ARRAY
: ALPRO	TS)	25		0.0 0.0 0.0 0.0 100.0 100.0 100.0 100.0	LOAD EXTREMES 0.0 0.0 0.0 0.0		0.001	LOAD EXTREMES 0.0 0.0		0.0	LOAD E	TRAILER TRAILER TRAILER
LOCATION : ALAROOK A B, PAH	LOAD (WATTS)	* DUTY	LRG TRAILER	LOLP AVAIL 1	LOSS OF L MAX MIN	SH 1 TRAILER	LOLP	LOSS OF PAX HIN	SM 2 TRAILER	LOUP	LOSS OF LOAD EXTREMES HAX 0.0 HIN 0.0	LRG TRAILER SM 1 TRAILER SM 2 TRAILER

CATION : ALAROOK A B, PAP LATITUDE : A.A

	2000	50 75		\$ \$	\$\$		\$ \$	××.
	20	20		! !	1 1		\$ \$	X X X
		22		98.9	£0,		X X X	\$ \$
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	1000	50 75			11		< < <	\$ \$
	2	20		1.1	6.0		¥ X 2 X	* * *
5.0		25		100.0	0.0		4/2 2/2	X X X X X X X X X X X X X X X X X X X
BATTERY SIZE (KWh) : 20.0 BATTERY SIZE (KWh) : 5.0		100		1.1	6.0		X X	* * *
S12E	200	75		99.9	0.0		* * *	* * *
AATTER) AATTER)	•	20		0.00	0.0		\$ \$	* * *
13.0		25		0.0 0.0 100.0 100.0	0.0		3.6	26.4
		_			0			
TERS)		100		9.0	0.0		\$\$	* * *
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REAY		¥n		100.	X O		m 96	26. 26.
	E S	25		0.0 0.0 0.0 0.0 100.0 100.0 100.0 100.0	0.0		0.0 3.6 100.0 96.4	10AD 0.0
LL. TRAILER SM. TRAILER	LOAD (WATTS)	* DUTY	LG. TRAILER	LOLP AVAIL 1	LOSS OF LOAD EXTREMES MAX 0.0 0.0 MIN 0.0 0.0	SK. TRAILER	LOLF	LOSS OF LOAD EXTREMES MAX 0.1 26.4 HIN 0.0 0.0

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LOCATION : MIMERIA, SPAIN	: ALME	RIA, SI	PAIN	3	LATITUDE : 37.0	37.0										
TOAD (WATTS)	(TTS)	-	125			15	250				540		,, ,	ביניי נייי	ν •	
* DUTY	75	5.0	75	פייו	2.5	8.	7,	101	25	S.	7.	Ē,	•			
LRG TPAILER								•	ć	6	-	!	ς.	1	1	4 :
LOLP AVAII.	0.0 0.0 0.0 0.0 100.0 100.0 100.0 100.0	10.001	0.00	100.0	0.0	0.0 0.0 0.0 0.0 109.0 100.0 100.0 100.0	0.00	0.00 100.0	100.001	100.0		1 1	101.9	:	1	
LOSS OF LOAD EXTREMES HAX 0.0 0.0 HIN 0.0	0.0 0.0	XTREMES 0.0 0.0	6.0 0.0	0.0	0.0	0.0	0.0	9.0	0.0	0.0	11.5	1 1	e.e.	11	!!	1. f.
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LOLP AVAIL	0.0			N/N	; ;	E X	Z Z Z	< < <	< < <	(<u> </u>	*	W. 1	W/11	<u> </u>	4/:	:. :
LOSS OF MAX	LOSS OF LOAD EXTREMES INA 0.0	TERME	y.	M/N A/N	11	1,1 1,1	X Z X X X X X X X X X X X X X X X X X X	1,7 1,7 1,7	N/N N/N	N/N	N/N N/N	H/A H/A	4/F	47. 17.	4 X	n et Kala
SM 2 TRAILER	~								2			٩/١	N/11	£, 11	#/# !	
LOLP	0.001	11	~ × ×	N/N N/A		V V V	¥ × ×	4/H 4/H		, E	1/N	٧,٢	n/A	6 /2	K./H	 :
LOSS OF	LOSS OF LOAD EXTREHES HAX 0.1 HIN 0.0	EXTREME	7,11 H/A H/A	N/N 11/A	; ;	N/N	¥ %	H/H	H/H K/N	M // 12	K K K	N/N N/N	11/k	E/A E/A	17.7 11.7 11.7	n i
LRG TI SM 1 TI SM 2 T	LRG TRAILER SM 1 TRAILER SM 2 TRAILER	ARRAY ARRAY ARRAY	(50. (50. (50.	ARRAY (SO. METERS) ARRAY (SO. METERS) ARRAY (SQ. METERS)	. 40.0 . 5.0 . 3.5		NATTERY SIZE NATTERY SIZE NATTERY SIZE	NATTERY SIZE (KWh) : 35.0 NATTERY SIZE (KWh) : 5.0 NATTERY SIZE (KWh) : 6.0	: 35.9 : 5.0 : 6.0							

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	RATTERY SIZE (kWh) : 20.0 RATTERY SIZE (kWh) : 5.0			100		1.4 98.6	12.6		X X	* * *
	SIZE	200		50 75		99.9	0.0		* * *	XXX XXX
	ATTERY ATTERY	¥n		20		0.001	0.0 0.0			
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	ER AF		E)	25		9.0 0.0 0.0 0.0 100.0 100.0 100.0 100.0	LOAD E. 0.0 0.0		0.0 9.6 100.0 90.4	LOAD E 0.0 6.0
LUCKITUM : WINDER ST.	LG. TRAILER ARRAY (SO. MITERS) : 60.0 cm. TRAILER ARRAY (SQ. METERS) : 13.0		LOAD (KATTS)	1 DUTY	LG. Trailer	LOLP	LOSS OF LOAD EXTREMES HAX 0.0 0.0 0.0 HIH 0.0 0.0 0.0	SM. TRAILER	LOLP	LOSS OF LOAD EXTREMES HAX 0.0 96.3 HIN 0.0 0.0

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125 5 50 75 100 25 50 75 100 2 5 50 75 100 25 50 75 100 2 6 0.0 0.0 0.0 0.0 0.0 0.0 100.0	טרמן	50 75 190 75 59 75 190		C. M. 1.1 0.0 1.1 0.0	1, 1 5, 6,	0.0 0.0	81/18	M/A H/P H/A	A HZA HZA PZA PZA PZA PZA PZA	11/11	11/4 N/4 N/11	43. 43.	c • •
100 25 100 25 100 0.0 0 0.0 0.0 0 0.0 0.0 0 100 0.				•									(kWh) : 15.0 (kWh) : 5.9 (kWh) : 6.9
100 25 100 25 100 0.0 0 0.0 0.0 0 0.0 0.0 0 100 0.		75A 75		0.0	ט זמט.מ זממ	0.0	•	4/H	N/N N/N				DATTENY SIZE BATTENY SIZE BATTENY SIZE
0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	TUDE : 29.5		i	6	100.0 100.								40.0
(WATTS) 125 Y 75 50 7 Y 75 50 7 FR 0.0 0.0 0.0 C 100.0 100.0 100.0 LER 0.0 0.0 0.0 LE					0.001 0.								(SO. NETERS) (SO. NETERS)
(#ATTS) Y 755 Y 755 TER 0.0 LER 0.0	Antento, 1	125			0.0 0. 100.0 100.			1 1			1 1		AREAY
LOCATI LOAD LOBE AVALL LOSE MAX HIN SH J TRAI LOSE HAX HIN SH J TRAI LOSE AVA HIN SH Z TRAI LOSE HAX HIN SH Z TRAI LOSE HAX HIN HIN HIN HIN HIN HIN HIN HIN HIN HIN	T10N : 5AU	artes	<u> </u>	1.58	LOLF 0.0 AVAIL 100.0	5 OF LOAP E	SH) Trailer	LOLP 0.0	55 OF LOAD 1 0.0 0.0	SM 2 TRAILER	LOLF 0.8 AVAIL 100.0	LOSS OF LOAD HAX 0.1	LPG TEATURE

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	9	75		11		,	< < <	4 X
	1000	50 75		1.9 98.1	0.0	÷	X X	K/2
20.0		25		100.0	0.0		1 1	; ;
BATTERY SIZE (KWh) : 20.0 RATTERY SIZE (KWh) : 5.0		100		1.9	11.11		X X X	< < < < < < < < < < < < < < < < < < <
321S	200			99.9	0.0		× ×	< × ×
ATTERY	ň	50 75		0.00	0,0		1 1	! !
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ARRAY (SO. METERS) : 60.0 Array (So. Meters) : 13.0		100		0.001	ø.0		} }	11
0. ME	150	75		0.001	0.0		11	; ; ;
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 LG. TRAILER	LOAD (WATTS)	• DUTY	LG. TRAILER	LOLP AVAIL 1	LOSS OF LOAD EXTREMES MAX 0.8 0.0 MIN 0.0 0.0	SM. TRAILER	LOLP	LOSS OF LOAD EXTREMES MAX 0.1 71.1 MIN 0.0 0.0

LOCATION : SFOUL, KOREA	MIL, KORE	<	LAT	LATITURE : 37.6	37.6								ניניו	_	
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LOAD (WATTS)	125	'n				250	60	25	50	75	100	ž	2,	, ,	Ę.
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LRG TRAILER						6	0	0.0	0.0	ب د ب	1	0.0	t 1 1 1	11/A 11/A	\$ 78
LOLP 0.0 AVAIL 100.0	0.0 0.0 0.0 0.0 100.0 100.0	0.0	0.00	160.0	160.0 100.0 100.0 100.0	0.06	0.00	100.0 100.0	v. vu	7.7		c	() (£:	4: 12
LOSS OF LOAD EXTREMES MAX 0.0 0.0 HIR 0.0 0.0	EXTREMES 0 0.0 0 0.0	0.0	0.0	0.0	0.0	e.e	0.0	0.0 0.0	c c c e	64.0 0.0) 	. c	1 9 1	5 2	ب ب
SH 1 TRAILER						;	4	×/*	4/2	N/N	V/W	N/H	< <	Κ.Σ (, ξ,	gs e grad
1.0LP 0.0		¥ < <	₹ ₹ ₹	11	X X X	X X X	K (/ R	K/8	11/11	*	٧/2	: ;			<
<u> </u>	EXTPEMES 0	× × ×	N/N H/A	!!	N/N	× × ×	8/H	N/N N/N	N/N N/N	# \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\ \\	4,7 E	1/2 1/2 1/2	4 × 3	*	
SH 2 TRAICER								××	R/A	N/n	4/H	N/N 1/7	5% 5%	7.75 3.78	e ji K
LOLP 0.1 AVAIL 04.9	1.6.	¥ £	۲ × ۲ ×	; ;	¥ X X	¥	A',N	*			۲ <u>:</u>	* * * * * * * * * * * * * * * * * * *	<u>ج</u> د	#, #	<. 10
LOSS OF LOAD EXTREMES MAX 1.2 HIN 0.0	1.2 0.0	8. 4/5 8/4	N/N N/A	! !	N/N 1.	X X X	4/N	4/N 4/N	2 2	X X	4/2 4/3	¥/4	, 5 .	<u>\$</u> 5	
LRG TRAILER SH 1 THAILER SH 2 THAILER	R ARRAY SR ARRAY SR APRAY	(80. (50. (50.	(SQ. METERS) (SQ. METERS) (SQ. METERS)			RATTERY SIZE RATTERY SIZE RATTERY SIZE	28 (kwh) : 38 (kwh) : 38 (kwh) :	35.0							

LOCATION : SEOUL, KOREA	SFO	UI., KC	JREA		2	ATITU	LAT1TUDE : 37.6	37.6								
LG. TRAILER SM. TRAILER	LER A	ARRAY (SO, METERS) : 60.0 Array (SO, Meters) : 13.0	(SO.	METE	RS) :	13.		RATTERY SIZE (KWh) RATTERY SIZE (KWh)	SIZE	(kWh) : 20.0 (kWh) : 5.0	20.0 5.0	,	ć			200
LOAD (WATTS)	TTS)		250						200	;	ř	2 5	1000	100	25	20
* DUTY	25	20		75	100		22	20	25	100	67	3	2			
LG. TRAILER										,	•	•	}	K/N	3.9	¥.
LOLP	0.0 0.0 0.0 0.0 100.0 100.0 100.0 100.0	100.0	100	0.0	0.00	_	0.00	100.0 100.0	99.6	96.1	100.0	96.1	}	K/N	96.1	X
LOSS OF LOAD EXTREMES MAX 0.0 0.0 MIN 0.0 0.0	LOAD EXT 0.0 0.0	EXTREME 0.0 0.0		0.0	0.0		0.0	0.0	0.0	30.7	0.0	30.7		* * * * * * * * * * * * * * * * * * *	30.7	< < < ×
SM. TRAILER											2	× ×	× ×	< ×	N/N	¥.
LOLP AVAIL	0.00	14.5			* * Z		14.5	* * * * * * * * * * * * * * * * * * *	<u> </u>	< < <	Y X	Z Z	K/N	<u> </u>	2	S
LOSS OF MAX MIN	1.0AD	LOAD EXTREMES 0.1 100.0 0.0 0.2		11	X X X	•	100.0	* * ·	X X X	X X X	N N N N N N N N N N N N N N N N N N N	K K K	X X X	< × ×	X X X	< < < > 2 × 2

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c. e	, e	•	. e.	0.0		< < ₹ £	K/21	:	* * ::	A,r	BATTERY SIZE (PATTERY SIZE (PATTERY SIZE (
LATITUDE : 39.0	25	,	0.0 0.0 0.0 101.0 100.0 101.0	0.0					1 1	1 1	40.0 5.0 3.5
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וונדטיו	175		0.0	0.0 0.0 0.0			TRFMES			XTRENE 	APPAY (SC. METERS) Arpay (SC. Meters) Array (SC. Meters)
VASBI	(غ. عرد		0.0 0.0 0.0 0.0 100.0 100.0 100.0 100.0	LOSS OF LOAD EXTREPES 11AX 0.0 0.0 0.0 MIN		3.7	LOSS OF LOAD EXTREMES MAX 16.4 MIN 0.0		11	LOSS OF LOAD EXTREMES	LRG TRAILER SM 1 TRAILER SM 2 TEAILER
 E	KATT		=	Ē	ž		0F 1	#3 7		OF.	AT AT
LOCATION : VASHINGTON DC	LOAD (KATTS) A DUTY	LPG TEALLUR	LOLP AVA I L	LOSS C	SH 1 TRAILER	LOLP AVA 1 L	LOSS	SM 2 TRATGER	LOLP AVATE	1.058 7.8 X PITN	LRG SM 1

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	20	20		11	! }		\$ \$	**
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	1000	50 75		11	11		\$ \$	# X X
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8.9		28		99.5	0.0		X X X X X X X X X X X X X X X X X X X	×× 22
BATTERY SIZE (KWh) : 5.0		100		11	11		* * * * * * * * * * * * * * * * * * *	** **
512E	200	75		11.6	0.0		* * X	X X
ATTERY	*	20		99.5	4.1 100.0 0.0 0.0		* * *	X X
13.0		25		100.0	0.0			11
		_		10.10				
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SH. TRAILER	LOAD (WATTS)	↑ DUTY	LG. Trailer	LOLP 0.0 0.0 0.1 AVAIL 100.0 100.0 99.9	LOSS OF LOAD EXTREMES HAX 0.0 0.1 HIN 0.0 0.0	SM. Trailer	LOLP	LOSS OF LOAD EXTREMES MAX 8.7 MIN 0.0

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THE STATE BY SOLUTION STATE BY STEE (WHY): 5.0 TO FID DO		0.0	0.0	0.001		-			16.7 83.1	16.8 81.2		1.8	16.8 81.2			4.71 7.18		
LER 14.7 H/A H/A N/A H/A N/A H/A H/A H/A H/A H/A H/A H/A H/A H/A H	LOSS OF MAX MIN	1,040 F. 0.0 0.0	XТВЕМЕ 0.0 0.0					ו 0.17 ח.ח	0.0	0.001		0.0	0.0	; ;	1 1 1		1 1	
	SM) TRAILER															:	:	
	LOLP AVAIL	14.7						× × ×	<u> </u>	< < <		× ×	N/N N/N	4	4/4 11/4	es n k	2 et. 	
CF ICAD EXTREMES N/A	LOSS OF MAX MIN	100.0 100.0	XXTPEAL 					× × ×	X X X	X X X		¥	H,/N N,/N	4/2 4/2	8'A 11, A	я. Кк	11 i	
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LATITUME : 48.1 LOCATION : HUBICH, W GERMANY

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IG. TRAISER SM. TRAILER	LOAD (WATTS)	t DUTY 2'	LG. TRAILER
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HIN 0.0 0.0 0.0 0.0 | | 11 ! ! LOSS OF 1 SM. TRAILER LOLP

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LOAD (WATTS)	* DUTY	LRG TRAILER	LOLP	LOSS OF LOAD EXTREMES HAX 0.0 0.0	SM 1 TRAILER	LOLP	LOSS OF LOAD EXTREMES HAX MIN	SH 2 TRAILER	LOLP	LOSS OF HAX HIN	LNG TRU SN 1 TRU SM 2 TRU

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LATITUDE : 52.2

LOCATION : CAMPRIME, U.K.

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LATITUDE : 52.7 SOCATION : CAMBRIDGE, U.K.

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16.0		; ;	2.6				!!	11		< X X	; ;	\$ \$		
LOSS OF LOAD EXTREMES MAX 0.5 23.4 100.0 HIM 0.0 0.0 0.1			23.8				11	11		# X X	!!	* *		
11		< < 2 × 2 ×		**	* *	* * *	* * *	* * *	\$ \$	* *	4/R	5 5	\$ \$	
EXTREMES		* *		4 X	< < < < < < < < < < < < < < < < < < <	4 K K K K K K K K K K K K K K K K K K K	M/N M/A	**	K K K	4/X 4/X	**	* *	\$ \$	

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LRG TRAILER	~														
LOLP	100.0	A.1	10.7		A.3	1 }		! !	11	; ;	1 1 1 1	; ;		! !	*/: */:
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1,055 0P 11AX 111B	LOSS OF LOAD EXTREMES	CXTREME	4/n 4/n 4/n	N/A H/A	1 1	N/A N/A	4/4 4/4	H/A H/A	N/N 11/A	K K K	8.7A 8.7A	554	8.78 8.78	< ()	K 6.
SM 2 TRATLEH	_														
1.01.P AVA 11.		× × ×	X X X	V/N	V/2 V/2	#/# #/#	X	¥ \	4/H 4/H	4 X X	¥,5	7.78 7.78	5 22	5 7	5 ()
LOSS OF	LOSS OF LOAD EXTPENSES	EXTPEAR N/A M/A	4/8 8/8 8/8	N/N N/N	3/A 11/A	H/A	4 /N	H/A H/A	11/A 11/A	, z ×	* * *	11/A 11/A	K/H K/R	6.5 8.5 8.5	15 5 16 1
LBC TR SH 1 TR SH 2 TR	TRAILER TRAILER TRAILER	ARRAY Array Array		(SO, NETENS) (SO, METENS) (SC, METENS)	 6.2 6.2	AATTER PATTER NATTER	AATTERY SIZE Dattery Size Nattery Size	(KEH)	. 35.0 . 5.0 . 6.0						

LATITUDE : 58.4

LOCATION : JUEUCAU, ALASKA

LOCATION : JUENEAU, ALASKA LATITUDE : 58.4

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		20		\$ \$	* * *		\$ \$	**
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S17E S17E	200	75		11	!!		* *	\$ \$
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ARRAY (SQ. METERS): 60.0 PARRAY (SQ. HETERS): 13.0 P		25		11.4	100.0		! !	! !
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	TTS)	25		3.8 11.4 96.2 88.6	LOSS OF LOAD EXTREMES HAX 44.1 100.0 HIN 0.0 0.1		11	LOSS OF LOAD EXTREMES MAX
IK.	(MA	č	CER	د	0	E	د	6
LG. TRAILER SM. TRAILER	LOAD (WATTS)	1 DUTY	LG. TRATLER	LOLP	LOSS MAX MIN	SM. TRAILER	LOCF	LOSS MAX NIN

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APPENDIX A

COMPUTER RUNS

(SUPPLIED PREVIOUSLY)

APPENDIX A

This appendix contains the detailed output from the computer runs analysing the performance of five photovoltaic trailer array configurations. These were:

Trailer	Array (m ²)	Battery Storage (kWh)
Large	60	20
Large	40	35
Small	13	5
Small	5	5
Small	3.5	6

The output presented here is shown on a more detailed (monthly) basis than dealt with in the body of the report.

To read the charts note the fact that each one was generated for a single load, either 1000 or 2000 watts, and a range of duty factors. Smaller loads must be interpreted by the appropriate duty factor of the larger load. For example, using the chart for Jerusalem covering the 60 m² array and 20 kWh battery, find the availability for 1000W at 75% duty cycle in the month of December.

Step 1. $\frac{2000}{1000} = 50\%$ (the column equivalent to 1000W at 100% duty factor)

- Step 2. $50% \times 75% = 37.5%$ (the column of interest, 1000W at 75% duty cycle)
- Step 3. Read down the 37.5% column to find LOLP for December. It is .60740, therefore availability = 1 .60740 = .3926 or 39%

Conclusion: If a 75% duty cycle for a 1000W load is required in Jerusalem in the month of December with an availability of 80% or better, this system will probably fail to meet the load with sufficient reliability. Note however, that performance in all the other months exceeds the requirements.

For convenience the charts are arranged as before in order of best performing locations first. For each location the system sizes are presented in order of decreasing array size.

CITY: JEHUSALEK,ISRAEL.
LETTUDE: 1 3).8
LIST ARGLE: 1 3).8
LIST ARGLE: 1 30.0
ARRAY ARGA (%): 10.0
ARRAY EFFICIENCY (%): 10.0
BATTERY EFFICIENCY (%): 75.0 BATTERY CAPACITY (kWh): 20.0

100.01	₹.	9.9999	9.99999	9.9999	9.9999	9.9999	9,99999	9.9999	9,9999	9.94999	9.99999	9.9999	9.99999	1.00000	0.0000	9.9999	9.9999
75.04	ė	9.9999	9.9999	9.9999	9.9999	.32485	. ^0003	.00012	.01024	9.99999	9.99999	9.9999	9.99999	.69460	30540	9.9999	.00003
50.04	₽,	9.99994	1.00000	.42620	90000-	•0000	.0000	.0000	.0000	.0000.	₹6000.	9.99999	9.99999	.36893	.63107	9.9999	•0000
37.54	1.1	95890.	+1100.	.00055	*0000	.0000	*0000	*0000	.0000	.0000	.0000.	.01535	.60740	.05825	.94175	.60740	. 9000
12.0	1.1	.00013	.00002	00000	.0000.	.0000	•0000.	.0000	*0000.	0000	.0000	.00003	68000.	.0000	19991	69000	•0000
9.0	2.2	.0000	00000	*0000	.0000	*0000	•0000	.0000	•0000.	.0000.	•0000	00000	. 00005	000000	1.00000	.00005	0000
12.51	3.3	.0000	•0000	•0000	.0000	•0000	.0000	.0000	.0000	.0000	.0000	*0000	. 00000	*0000	1.00000	00000	•0000
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BATTERY CAPACITY	OF DAYS	KH*.610	KH*. 61	KH* . 622	KH680	кн712	KH752	KH=.750	KH=.749	KH732	KR696	KH620	KH568	AHMUAL AVG. LOLP 0.0	ANNUAL Availability 0.0	ARRUAL LOLP Haximums 0.0	ARNUAL LOLP Minimis 0.0
25	4 04	JAR	427	KAM	APR	¥	Nac	JOL	AUG	SEP	ğ	ž	DEC	ANRU AVG.	AVAILAL O.O	ARMU HAXII	AMPO

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CITY: JERUSALTH, ISRAFL
LATITUDE: 31.8
TILT ANGLE: 31.6
LAGA (WATES): 1000.
ARAY AREA (SO. METERS): 40.0
ARRAY EPPICIENCY (%): 10.0
BATTERY EFFICIENCY (%): 75.0 BATTERY CAPACITY (WWh): 35.0

CAT	BATTERY	DUTY FAC	3.1% 6.3%	/day 9.48	12.54	18.84	25.04	37.54	50.04	75.04	100.0
1 OF DAYS	DAYS	46.7	23.3	15.6	11.7	7.8	8.8	9.6	2.9	•.	
JAN	KH=.610	00000.	*0000.	.0000	•0000.	*0000*	*0000	•0000	.00163	00000	0.00
FEB	KH=.61	.00000	*0000	*0000	*0000	*0000*	•0000	•0000	.00063	0 0 0 0 0 0 0 0 0	0.
HAR	KH=.622	.00000	*0000	*0000	.0000	*00D0°	*0000.	•0000	•0000.	0.000.000	0.000
APR	KH*.680	0.0000.0	00000	*0000	•0000	*0000	.0000.	.0000.	•0000.		
MJ.Y	KH=.712	0.00000	0.00000	00000	.0000	*0000	*0000	*0000*	*0000.	• 4999	
JUN	КН=.752 0.	52 0.0000	0.0000.0	0.0000.0	0.00000	0.0000	0.0000.0	0.0000.0	.00000	•6000.	****
JUL	KH*.750	0.00000	0.0000.0	0.0000.0	0.0000.0	00000-0	0.00000	0.00000	,,,,,,,,	• 66000	
AUG	KH*.749	49.00000	0.0000.0	0.0000.0	0.00000	0.00000	0.00000	0.00000	,00000	•6066-	
S	КН=.732 0.	32 0.00000	0.0000	0.0000.0	0.00000	0.0000.0	0.0000.0	00000	•0000•	• 0000.	
500	жн≈.698 0	0.00000	.00000	*9000*	.0000	*0000	*0000*	•0000.	•0000.	. מחמה.	
MOM	KH*.620	20	*0000	*0000*	*0000*	*0000*	*0000*	•0000.	. 1000.	60000	6. 6.
DEC	Kii588	.00000	*0000	*0000*	•0000•	*0000	*0000	1,0000.	.07543	60000	0665.6
ANG. LOLP O.0	AL LOLP 0.0	.00000	•0000.	•0000.	•0000.	•0000	•0000•	*0000*	.00643	.41722	
ANNUA AVAIL O	ANNUAL AVAILABILITY 0.0	1.00000		1.00000	1.00000	1.06000	1,00000	1.00000	.99357	.54278	.3316
ANNUAL LO MAXIMUMS 0.0	ANNUAL LOLP MAXIMUMS 0.0	.00000	.0000	.0000	•0000.	•0000.	*0000.	10000.	. 47541		
ANNUA Minih O	ANNUAL LULP Minimums 0.0	0.0000	0.00000	0.00000	0.0000	0.0000	0.0000	0,0000	.00000	•0000	

9.99999 9.99999 0.0000.0 1.00000 9.9999 9.9999 9.99999 9.9999 9.9999 9.9999 9.99999 9.9999 9.9999 9.99999 9.9999 9.99999 75.0% 36.0 9.9999 9.9999 1.00000 0.0000.0 66666.5 9.99999 66666.6 666 . . 6 9.9999 66666.6 65666.6 9.9999 9.99999 9.9999 59.04 24.0 9.95999 9.9999 9.9999 1.00000 9.99999 0.0000.0 66646.5 9.99999 9.9999 9.99999 9.9969. 9.9999 63636.6 66666.6 9.99999 9.99999 37.58 65666.6 9.99999 9.9999 9.99999 0.0000 1.00000 9.9999 6686676 9.99999 66666.6 9.99999 9.9999 9.9999 66666.6 96666.6 9.99999 9.99999 25.04 12.0 9.29999 1.00000 9.9999 0.0000.0 1.0000 9.9999 9.99999 € 66666 66666.6 9.99999 9.99999 9.9999 1.00000 6.896.9 9.99999 9.9999 9.9999 3.0° 5.0 •0000 .52364 9.9999 .47636 9.99999 66066-6 11406 00000. *0000. CITY: JERUSALEM, ISTARÉ
LATITUDE: 31.8
TILT ANGLE: 31.8
LAND (WATES): 2000.
ANENY AREA (SO. METERS): 13.0
ANENY EFFICIENCY (%): 10.0
BATTERY EFFICIENCY (%): 75.0 BATTENY CAPACITY (kWh) •0000 .0000 .00223 **,0000**. 9,99999 9.9999 96666.6 12.5¢ 6.0 .0000 5.99999 .79436 .20564 .35417 9.9999 .0000 00000 .0000 .0000 •0000 .10770 .0000 •0000 .00579 1.00000 4.5 DUTY FACTORS 6 kWh/dev 9. 3.10 5.0 4. 1.5 3.0 4. 3.3 .0000 .00321 .99969 .00321 .00031 .0000 .00008 .0000 .0000. •0000 .0000 *0000. .00005 .00038 ,0000. .00000 90000 00000 1.00000 00000 .00000 00000. 00000 .00000 .00000 .00000 .00000 .00000 .00000 00000 .00000 KH-.588 KH-.620 KH-.698 KH*.750 KIS-.712 KH=.752 KH-.680 ANNUAL Availability 0.0 ANNUAL LOLP MINIMUMS 0.0 KII-.622 ANNUAL LOLP MAXIMUMS 0.0 ANG. LOLF BATTERY CAPACITY 0.0 OF DAYS 230 Š ģ AUG SEP JUN ЗÜГ ž JAK ¥

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50.01	6.994.9	06666°6	66666.6	66666.6	66666.6	9,99999	66666*6	66666.6	66666.6	66666.6	9.99999	66666.6	1.00000	0.0000		66664'6
37.5% 9.0	9,99999	66666*6	66666.6	66666.6	66666.6	66666.6	66666.6	66666'6	66666.6	66666.6	9.99999	66666.6	1,00000	0.00000	9.99999	9.9999
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18.88 4.5 1.1	66666°6	66666*6	66666*6	6666666	6,9999	9,99999	66666.6	66666.6	66666.6	66666.6	66666.6	9.99999	1.00000	0.00000	9.99999	9.99999
12.58	66666.6	66666.6	66666.6	65666.6	00600.	•0000.	.0000	.00000	9.59399	9.99999	96866.6	66666.6	.66744	. 33256	9.99999	*0000*
day 9.48 2.2 2.2	66666.6	9.99999	9.99999	*0000	*0000	.00000	00000.	00000.	÷0000°	.00305	9,99999	9.9999	.41692	.58308	66666.6	00000.
HITT FACTORS & KUD/đay 3.1% 6.3% 7 1.5 6.7 1.3	000070	.0000	*0000	•0000.	.0000	0.0000.0	0.0000	0,000,0	00000.	*0000	*0000 .	.04578	.00388	.99612	.04578	0.0000
11.18 3.18 .7 6.7	.0000	•	.00000	00000.	. 00000	0.00000	ки».750 0.00000	;q ,0,00000	3.2 0.00600	00000°	000000.	88 .00000	.00000	1.00000	.00000	0.0000
FATTERY CFENCITY OF LAYS	el	K13=, = 1.4	FB**623	F8++630	Kus. 71?	KII*.752	KH* . 75	KH=,7:9	KI!=.732	He⊃, ≃HS	КН≈.620	KH*,589	ATHUAL AVG. LOLP 0.0	anrual Availability 0.0	ARRUAL LOLP KAXIMUSIS 0.0	ANNUAL LOLP HIPIHUIS 0.0
1 10	-	#3.1	*; ;	14 24 47	? ;	30%	1.10	2.53	a: Liv	ţ	1:07	PEC	Arrual Avg. Lo	AVALLA 0.0	KAX	MNA

CITY : JERUSALEM, ISRAEL
LATITUDE : 31.8
ILL ANGLE : 31.8
LOAD (MATE) : 3.5
ARRAY AREA (50. METERS) : 3.5
ARRAY EFFICIENCY (1) : 10.0
BATTERY EFFICIENCY (1) : 75.0 BATTERY CAPACITY (KMb) :

24.0	6. 6.	0.000			, 13000	0.000	ceóué é	δ ό υ ό δ * δ	0.000	00000° ó	56666	6000	1.69990	1.00011	*****	6 C C C C C C C C C C C C C C C C C C C
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12.9	666666	9.99999	99999	699999	00000	ούοου · 6	666666	00000°0	66666.6	66666.6	9.99999	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	1.00900	0.0000	************	erree's
9.0	66666.6	66666.6	60000.6	6,9999	6,9999	6666666	9.99999	0 6600°6	66666.6	66666	9.99999	9.99999	1.00000	0.0000.0		****
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2.0	66666.6	66666.6	66666.6	66666.6	9.99999	66666.6	9.99999	9.99999	66636*6	66666.6	9.99999	66666.6	1.00000	0.0000.0		64664.6
2.7	9.99999	9.99999	6666666	64666*6	9,94999	00000.	.00000	1.00000	9.99999	66666.6	á6666°6	9.99999	.83333	.16667	66465.6	. 00000
4.0	9,99999	6666.6	.71254	*0000	00000	0.00000	0.0000.0	.00060	.00000	*0000	9.99999	9.99999	.39271	.60729	*****	0.00000
.0.8	00000.	51 4 .00000	, 00000	580 .00000	0.00000	752 0.00000	0.00000	0.00000	0.00000	00000.	. 00000	.00000	.00000	1.00000	00000.	0.0000
OF DAYS	JAN KII".	FEB KH*.	MAR KH=.	APR KII*.	MAY KII-,	JUN KH=.	JUL KH1	AUG KH=,7	SEP KH*.1	ост кн-, 6	NOV KH 6	DEC KH=.5	ANKUAL AVG. LOLP 0.0	ANMUAL Availability 0.0	ANNUAL LOLP MAXIMUMS 0.0	AMNUAL LOLP Minimums 0.0
	6.0 4.0 2.7 2.0 1.3 1.0 .7 .5 .3 .3	., 1.5 2.2 3.0 4.5 6.0 9.0 12.0 18.0 7 .5 .3 .3 .3 KH=.610 9.99999 9.99999 9.99999 9.99999 9.99999 9.99999 9.99999 9.99999	., 1.5 2.2 3.0 4.5 6.0 9.0 12.0 18.0 17.0 18.0 17.0 18.0 17.0 18.0 17.0 18.0 17.0 18.0 17.0 18.0 17.0 18.0 17.0 18.0 17.0 17.0 17.0 17.0 17.0 17.0 17.0 17	KH=.610 KH=.614 C00000 9.999999	KH=.610 KH=.610 KH=.614 .00000 9.999999	KH=.610 KH=.610 KH=.610 KH=.610 KH=.610 KH=.610 KH=.610 COURTOO 9.999999	KH=.610 KH=.610 KH=.614 .00000 9.999999	KH=.610 .00000 9.999999	KH=.610 KH=.614 COUCOO 9.99999 9.99	KH=.610 L00000 9.999999	KH=.610 LO0000 9.999999	KH610 .00000 9.999999	KH610 LOUGOO 9.999999	KH610 .00000 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 9.69999 0.69999 9.69999 6.99999 KH612 .00000 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 9.69999 0.69999 0.69999 KH622 .00000 .00000 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 0.69999 0.69999 KH752 0.00000 0.00000 0.00000 9.59999 9.59999 9.59999 9.59999 9.59999 KH754 .000000 0.00000 0.00000 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 KH628 KH628 .00000 0.00000 0.00000 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 KH658 .00000 0.00000 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 KH658 .00000 0.00000 9.599999 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 9.59999 9.599999 9.59999 9.59999 9.59999 9.59999 9.59	11-510 1-510	1-510

CITY: HOMOLULU, HAMAII
LATITUDE: 1 21.3
LILT ANGLE: 21.3
LOAD (WATES: 2000.
ANHAY AREA (50, METERS): 60.0
ANHAY EFFICIENCY (%): 10.0
BATTERY EFFICIENCY (%): 75.0 BATTERY CAPACITY (KWh): 20.0

	100.00	9.9999	9.9999	9.9999	9.9999	9.99999	9.99999	9.99999	6.666.6	9.99999	9.9999	9.9999	9.59999	1.90000	0.0000	9.9999	9.9999
	75.0% 36.0	9.9999	9.99999	9.99999	9.9999	9.9999	9,9999	9.9999	66666.6	9.9999	9.9999	9.9999	9.9999	1.00000	0.0000	9.9999	9.9999
	50.0% 24.0	9.9999	9.99999	66666.6	1.00000	. 24523	.12166	.10730	.12224	1.00000	9.99999	9.99999	9.9999	.71637	. 28363	9.9999	.10730
	37.51	1.00000	91651.	.03517	.01027	.00709	.00109	68000.	.00073	.00260	.03296	. 59649	1.00000	.23684	.76316	1.00000	.00073
	25.04 12.0 1.7	.00493	.00097	.00027	.00014	.00003	.00002	.00001	.00001	. 00002	.00020	.00231	.00631	.00127	.99873	.00631	.00001
0.02	18.85 9.0 2.2	.00038	.0000	.00002	.0000	00000.	.00000	.00000	•0000.	00000	.00002	.00018	.00343	.00010	99990	.00043	*0000
CAFACLUS (RRIII)	12.58 6.0 3.3	.00003	.00001	00000	.00000	•0000	•0000.	•0000.	*0000	.0000	.00000	.00001	.00003	.00001	.99999	.00003	•0000
DAILCRE CAFA	/dey 9.48 4.5	.00003	.00000	•0000.	•0000.	•0000	*0000	.0000	•0000.	•0000	•0000.	.00000	.00001	.00000	1.00000	. 60001	•0000.
	TORS 6 kWh/de 6.3% 3.0 6.7	00000	•0000•	•0000	*0000°	•0000.	*0000	*0000	•0000.	*0000°	•0000.	00000	.00000	•0000	1.00000	00000	•0000
DALIERI ETTICIEMCI (1) : 73.0	DUTY FACTORS 6 3.1% 6 1.5	00000.	33	39	. 00000	00000.	76 .00000	. 00000	00000.	.00000	. 00000	.00000	.00000	00000	1.00000	00000	00000
ERI EFFIL	BATTERY CAPACITY OF DAYS	KH517	KH533	KH539	XB=.544	KH=.566	KH=.576	KH580	KH586	КН=.57₿	KH554	KH=.526	KB518	ANG. LOEP 0.0	AWNUAL AVAILABILITY 0.0	ANNUAL LOLP MAXIHUMS 0.0	AMNUAL LOLP Minimums 0.0
7	• •	ZAZ	FEB	HAR	APR	MAX	SUN	JOL	AUG	43 3	5	M	DEC	ANN AVG.	AWNUAL AVAILAI 0.0	AMMA	AMA

CITY : HOMOLULU, HAMAII

LATITUDE : 21.3

TILT ANGLE : 7 .3

LOAD (WATTS) : 1000.

ANRAY REFICENCY (*) : 10.0

AARAY REFICENCY (*) : 10.0

AARAY REFICENCY (*) : 75.0 BATTERY CAPACITY (*Mh) : 35.0

AATTERY EFFICIENCY (%) : 75	: 75.0 BATTERS CTORS & kWh/day	M				17.58	50.04	15.0%	100.00
٠٠	@ 12 L		12.5 4 3.0	18.84 7.8	25.0 5.0 5.8		12.0	18.0	1.5
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CITY: HOWOLULU, HAWAII
LATITUDE:: 21.3
TILT ANGLE:: 21.3
TOAD (WATTS):: 2000.
ARRAY ANEA (SO. METERS):: 13.0
ARRAY ENFOCIENCY (%):: 10.0
BATTERY EFFICIENCY (%):: 75.0 RATTERY CAPACITY (kWh)

ă ()	BATTERY CAPACITY	DUTY PACTORS	TORS & KWh/day 6.3%	//dev 9.48	12.51	18.01	25.04	37.51	\$0.00	75.04	
-	OF DAYS	3.3	3.0	1.1	0.6	0.6	12.0	18.0	24.0	36.0	
JAN	KH517	,00003	.01663	9.9999	9.99999	9.99999	9,99999	66666.6	9.94999	9.99999	9.9999
FEB	XH=.533	.00001	.00246	1.00000	9.9999	9.9999	9.9499	9.99999	9.9999	9.99999	9.9999
MAR	KH539	00000.	.00060	.40960	9.9999	9.9999	9.9999	9.99999	66666*6	9.99999	9.99999
APR	KH=.544	.00000	.00024	.06764	9.99999	9.9999	9.9999	9.9999	9.99999	9.99999	9.9999
МАХ	XH=.566	.00000	.00005	.01105	1.00000	9.95404	9.99999	9.99999	9.9999	9.99999	9.9999
NOC	KH+.576	000000.	.00002	.00537	1.00000	9.9999	9.9999	9.99999	9.99999	9.9999	9.9999
JOE	KH580	00000.	.00002	.00451	1.00000	9.9999	9.9999	9.99999	9.99599	9.99999	9.99599
AUG	KH~. 586	00000.	.0000	.00424	1.00000	9.91999	9.99999	9.99999	9.99999	9.99999	8.9:99
SEP	KH*.578	.00000	.00003	.02250	9.9999	9.9999	6.99999	9.99999	9.99999	9.9999	9.99999
8	KH=.554	. 00000	.00046	. 43879	9.9999	9.99999	9.9999	9.9999	9.99999	9.9999	9.9999
M O M	KH=.526	, 00001	.00688	9.9999	9.9999	9.9999	9.9999	9.93999	9.95999	9.9999	9.9999
DEC	KH=.516	.00003	.02296	9.9999	9.9999	9.9999	9.9999	9.9999	9.99599	9.9999	9.9999
ANMUAL AVG. LOLP 0.0	AL LOLP 0.0	.00001	.60420	.41364	1.00000	1.00000	1.0066	1.0000	1.00000	1.00000	1.00000
AVAILAL 0.0	ANMUAL AVAILABILITY 0.0	. 9999	.99580	. 58636	0.00000	0.0000	0.0000	0.00000	0.0000	0.00000	0.00000
AMMUAL LA MAXIMUMS 0.0	ANNUAL LOLP Maximums 0.0	. 06003	.02296	9.9999	9.9999	9.9999	9.99999	9.9999	9.9499	9.9999	9.9999
AMMUA	AMMUAL LOLP HINIHUMS 0.0	. 00000	.00001	.00424	1.00000	9.9999	. 99999	9.9999	9.9949	6666.6	9.99999

5.0	;
-	
(kWh)	
CAPACITY	
5.0 RATTEPY	1
CITY: HONOLULU, H. KAII LATITUDE: 1 21.3 TILT ANGLE: 21.3 TILT ANGLE: 21.3 LATA MATHS: 1000. ARRAY MATHS: 1000. ARRAY EFFICIENCY (*, 1). ARRAY EFFICIENCY (*, 1). ARRAY EFFICIENCY (*, 1).	AFTERY EFFICITOR

100.00	24.0	66066.	6000		00006° b	6.0909		000000	0 0 0 0	0		5.65	6660 · 0	6 6 6	90000	• •	ມາກຸກຸກຸ	C		•
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;	50.0% 12.0	66666		66866.	66666.6	6 0000 6	96696.6	nopan.6	0000		taóóu o	60660°6	866ú*6	66666.6	,	9.99999	1.00000	0.000.0		6.0 000.0.0
	37.54 9.0		. 66666.	6 66666.0	66666.	, 66666.6	66646.0	65666"6		7 7 7 7 7	9.99999	66666.6	6666666	65656.6		66666.6	1.00000	0.0000	600 6 0, 8	***
	25.0% 6.0 .8	•	6.9999	ĕ6666°	6 66666.6	66666.6	66666.6			6666676	66666*6	ú 0665.6	66666.6	000	30:55	66666.6	1,00000	0.0000		£\$686.\$
9.0	18.88		6 66666.6	6 6(556.6	9.93999	6 6666t´s	60000			66666.6	66666° 6	66666.	66666.6		6.666.6	60066.6	1.00000	0.0000	******	****
(kWh) s	12.54		. 6 6666.	6 66666.6	6 66665.6				6 66665.6	66666.6	66666*	9.999.9	9		66666.6	66666.6	1.06000	0.0000	******	00666
5.0 PATTERY CAPACITY (KWh)	9.48		6 66666.6	·6 66666.4			•	1.00000	.65147 9	.54872 9	1.00000	66666		66.66	66666.6	9.99999	.93335	.06665	66066.6	. 54877
5.0 O BATTER	DUTY PACTORS & "Wh/day	3.3	9.6 82818.	78800		, .		. 00000	• 7,000.	.0000.	.0000*	90000		.00023	.05227	1.00000	.11942	.88058	1.00000	•0000.
TERS): 5	ry PACTORS	6.3	. 00000				00000	. 00000	00000	,00400	00000		00000	00000.	00000.	.00000	00000	1.00000	00000.	00000.
ARRAY AREA (SQ. METERS) : ARRAY EFFICIENCY (%, 1 10 LTERY EFFICITALY (%)	RY DU		KH=.517	KB533	. и К⊞≖. ∴39	•	•	•	KH*.57+	кн580	KII*.586	KH=.578	755		кн=.526	KH518	At. 101.0	AMMUAL Availarii:ty 0.0	ANNUAL LOLP MAXIMUMS 0.0	AMMUAL LOLP Hinimums 6.0
ARRAY ARE ARPAY EF	DATTER" CAPACITY	# OF DAYE	JAN	FER	HAR.	9	š.	MAŸ	NOC	JOE	AUG	SEP	ļ	5	NON	DBC	ANMUAL AVG. LOLP 0.0	ANNUAL AVAILA 0.	ANNU	NIH!

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	0.9
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	(KW)
	CAPACITY
· •	BATTERY
	10.0
CITY: HOMOLULU, HAWAII LATITUDE: 21.3 TILT ANGLE: 21.3 LOAD (WATTS): 1000. ARRAY AREA (SO. METERS):	ARRAY EFFICIENCY (%): 10.00 nattery capacity (kWh): 6.0 nattery repiciency (%): 75.0 battery capacity (kWh):
CITY: H LATITUDE TILT ANG LOAD (WA	ARRAY EF

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37.54	۲.	6.6666.6	6.99999	66666.6	9.9999	9.99999	64664.6	i6666*6	50000.6	6bětu'6	6	9.9999	66466.6	1,00000	0.00000	•	roper, a
25.01) C	60066.6	66666°6	60066.6	9.99999	9.99999	66666.6	66666.6	9.9999	£6666°6	66666. é	9.91999	66966*6	1.00000	0.0000		
16.91	1.35	00000	66666.6	66606.6	9.99999	66666.6	66666*6	66656*6	66666.6	9.99999	66666 66	9.9994	66666"6	1.00000	0.00000	•	00000
12.54	3.0	66666.6	66666.6	9.99999	9.99999	66666.6	66666.6	9.9999	9.99999	66666.6	66666.6	9.9999	66666.6	1.00000	0.0000	\$660°	00000
Jav 9.48	2.2	9.9999	9.9999	9.99999	66666.6	9.99999	9.99999	9.9999	9.99999	66666.6	\$6666.6	9.9999	9,99999	1.00000	0.0000		99999
DUTY FACTORS & KWh/dav	1.5	66666.6	9.9999	9,99999	1.00000	.03420	.00475	.00346	.00583	1.00000	66660.6	9.9999	66666.6	.67069	.32931	éstaç.	21100
DUTY FACT	8.0	00000		00000.	.00000	.00000	00000.	00000.	00000.	00000.	.00000	26,00000	18	00000.	1.00000	, 00000	6
	CAPACITI OF DAYS	KH517	KH=.533	KH=.539	KH*.544	кн566	KH*.576	KH*.580	KH=.586	KH578	KH*,554	KH=.526	KH=.518	ANNUAL AVG. LOLP 0.0	ARRUAL AVAILABILITY 0.0	ANWUAL LOLP MAXIMUMS 0.0	ANNUAL LOLP MINIMUMS
PATTER PAR	1 10 1	JAN	FEB	HAR	APR	HAY	JUN	JUL	AUG	das	5	NON.	DEC	AVG	AVAILA 0.0	ANN	NIA

CITY: ALBHOOK A R. PAN
LATITUDE: 8.4
TILT ANGE: 8.6
TILT ANGE: 2.000.
ANATES: 2.000.
ANATES: 2.000
ANATES: 2.000
ANATES: 2.000
ANATES: 2.000
ANATES: 2.000
ANATES: 2.000

	7.000	9.9999	9.9999	9,9999	9.9999	9.99499	9.9999	9.9999	9.9999	9.4999	9.9999	9.9999	9.9999	1.00000	0.0000	9.9999	9.9999
	75.05 96.0 9.	9.99999	9.99999	66666.4	9.9999	9.9999	9.9999	9.9999	9.9999	9.99499	9.9999	9.9999	9.99999	1.0000	0.0000	9.9999	9.9999
	24.0	9.99999	1.00000	38161.	1.00000	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.94999	.93266	.06734	9.9999	.19166
	37.54 18.0 1.1	.33966	.00405	.00040	.00535	.67018	666-576	1.00000	1,00000	69990.	1.00000	.98222	.03692	. 5087è	.49121	9.9999	. 00040
	25.04 17.0 1.7	.00161	.00002	00000.	₽000 0.	.00527	.06758	.01850	.02020	95000.	.00745	.00489	.00034	.01051	. 98949	.06758	00000
	18.88 9.0 2.7	.00013	00000	•000u°	.00000	. 00054	.00676	.00188	.00218	.00005	₽4000.	.00042	.00001	.00106	16066.	. 00676	.0000
	12.54 6.0	.00001	.0000	•0000.	•0000.	.00005	.00061	. 0001	.00022	.00000	.0000	,0000.	•0000	.00010	.9999	.00061	•0000
	\$	00000	•0000.	•0000	•0000.	.00002	.0001	90000.	.00007	00000.	.00002	.00001	.0000	.00003	78666.	.00016	• 0000 .
1.61	DUTY FACTORS 6 kWh/dav 3.1% 6.3% 1.5 3.0 13.3 6.7	00000	.0000	•0000	•0000	.00003	90000	.00002	.00002	•0000	.00001	.00000	•0000.	.00001	9999	90000.	• 0000
NATTERY EFFICIENCY (1) 73.	3.16 1.5 13.3	•		00000	.00000	00000	.00001	.00000	,00000	00000.	.00000	00000.	00000	00000	1.80000	.00001	.00000
I EPPICIE	_ E	KH*. 505	KII+.572	KH=.596	КН≈.554	KII+.459	КН=. 390	KH*.428	KH=.422	KH=.508	KH=.457	KH=.478	KH=.554	AMMUAL AVG. LOLP 0.0	AMMUAL Availability 0.0	AMMUAL LOLP Haximums 0.0	ANNUAL LOLP MINIMUMS 0.0
RATTER	BATTER! CAPACI	NAC	424	¥ ¥	APA	¥	JUN	JUL	AUG	23	5	NOM.	DEC	AMMUAL AVG. L	ANMUAL AVAILA 0.0	ANT	ANNA

CITY: ALAROOK A B, PAN
LATITUDE: 8.6
TILT ANGLE: 8.6
LOAD (KATTS): 1000.
ARRAY AREA (SO. MITERS): 40.0
ARRAY FEPICIENCY (%): 10.0
BATTERY EFPICIENCY (%): 75.0 BATTERY CAPACITY (KMh): 35.0

E S	RATTERY CAPACITY	OUTY PACT 3.14 .7	DUTY PACTORS & WH/dav 3.1% 6.3% 7.7 1.5	'68v 9.41 2.2	3.0	18.84	25.01	37.5	50.01	74.03	
OF IMYS	AYS	46.7	23.3	35.6	7.10	7.B	æ. v	•,	ڊ. د.	°. -	
NAC	KH=.505	00000	*000u*	*0000,	.0000	.0000	•0000.	.00003	61110 .	0.00400	
FEB	KH=.577	00000	*0000.	.0000	*0600.	•0000	•0000.	•0000.	. 0000	96669.6	******
HAR	KII=.596	.00000	•0000.	.0000	•0000.	*0000.	*0000.	•0000.	•01111.	1.0000	crost.e
APR	KH=.554	.00000	•0000	•0000.	.0000	*0000	*0000.	*0000.	. 00002	00000.0	(
MAX	KH=.459	.00000	•0000	•0000	*0000.	.0000.	.0000	.00014	. 17803	• • • • •	,,,,,,,,
JUN	Кн= . 390	.00000	. 0000	*0000.	•0000	00000.	.00005	.02340	u0666° a		000000
300	KH=.428	.00000	•0000	•0000.	•0000	.0000	.0000	20100.	1,00000		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
AUG	KII*. 422	00000.	•0000	•0000.	*000u°	.0000	.00001	.00226	1.60000		
SEP	KH=.508	.00000	•0000.	*0000	•0000.	.0000.	.0000	00000.	#1.COO.	C C C C C C	******
Ş	KII=.457	.00000	*0000	*0000.	•0000.	•6600.	.00000	.04936	.75507	6 6000	8 0 C
¥Q¥	KH=.478	. 10000	*0000.	•0000	.0000	•0000.	•0000.	71000.	.1-208		•
220	KH*.554	.00000	•0000.	•0000.	•0000.	•0000.	.0000	.0000	.00 ,61	26606.	•
7	AMMUAL AVG. LOLP 0.0	.00000	•0000.	*0000.	•0000.	*000ņ°	. 0000	96200.	.30018	1,00900	1,29086
ANNUAL AVAILAI 9.0	911.17	1.09000	1.00000	1.00000	1.00000	1,00000	66660.	19600.	CBest.	9.0000	, , , , , , , , , , , , , , , , , , ,
XIX	ANNUAL LOLP MAXIMUMS 0.0	.00000	•0000.	*0000	•0000.	00000.	50000.	05520		.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
PINI D.	ANNUAL LALP MINIMURIS 0.0	. 00000	*0000.	•0000.	.0000	•0000.	•0000	• 0000	• 0000	1 22027	C

CITY: ALBROOK A B, PAN
LATITUDE: 8.6
TILT ANGLE: 8.6
LOAD (WATES): 2000.
ANRAY AKEA (80, METERS): 13.0
ANRAY EFFICIENCY (%): 10.0
BATTERY EFFICIENCY (%): 75.0 BATTERY CAPACITY (kWh):

100.00	9.9999	9.99999	9.9999	9.9999	9.99999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.99999	7.0000	. 0000	9.9999	9.9999
75.01 36.0	9.99999	9.99999	9.99999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	1.00000	9.0000	9.9999	9.9999
\$0.04 24.0	9.99999	9.9999	9.9999	9.9999	9.9999	9.99999	9.99999	9,9999	9.9999	9.9999	9.99399	9.99999	1.00000	0.00000	9.9999	9.9999
37.58	9.9999	9.9999	9.99949	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.99999	1,00000	0.0000	9.9999	9.9999
25.0% 12.0	9.9999	9.9999	9.9999	9.99999	9.9999	9.99999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	1.00000	0.0000	9.9999	4.9999
9.9. 9.0	9.9999	9.99999	9.9999	9.9999	9.9999	9.99999	9,99999	9.9999	9.99999	9.99999	9.9999	9.9999	1.00000	0.0000	9.9999	9.9959
12.54 6.0	9.99999	9.9999	9.99949	65666.6	9.9999	9.99999	9.9999	9.9999	9.99999	9.9999	9.9999	9.9999	1.00000	00000.0	9.9999	9.3999
/day 9,41 4.5	1.00000	.04109	,00344	.04499	1.00000	9.9999	9.9999	9.9999	.07521	9.99999	9.99999	. 70169	.72220	.27780	9.9999	.00344
FORS & KWh/dey 6.34 3.0 1.7	.00450	.00004	00000	.0000	.01384	.26367	.05538	.05935	.00126	.02043	.01396	.00035	.03607	.96393	.26367	00000.
DUTY FACTORS 3.1% 1.5	.00001	.00000	.00000	.00000	.00005	.0007	.00018	.00023	00000.	.00007	.00003	.00000	.00011	. 99989	.00071	00000.
BATTERY CAPACITY OF DAYS	KH505	KH=,572	KH=.596	KH=.554	KH=. 450	КН=.390	KH428	KH=.422	XH508	KH457	KB478	KB554	ANKUAL AVG. LOLP 0.0	AMMUAL Availability 0.0	ANHUAL LOLP MAXIMUMS 0.0	AMMUAL LOCA HINIHUMS 0.0
₽ 0 ₽	JAK	123	HAR	APA	MAY	NUC	301	YAC	128	8	MOM	DEC	ANK	AX AX	AMM	AIR

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75.01 190.00		00000° 0 000060°	o ó bóvou.	6° v pouch	ō 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6		. 0 0 0 0 0 1 0	o ouesu's	u p é t u ·	0 0 0 0 0 0	,	00000 6	v 6000 ° 6	1,00000	, n1710	6.60		
		٠	,	p. p. 69900.0	6.p 26psp.	,	· o obcoo	.6 pouév.6	0 00000	6 60000	, 900na	0000	600000	1,00000	0.0000	60000		
	9.0	60000 60006			0,		σ.	. 6 66686°	00000	60666	_		66666.6	1.00000	0.00000			
	0.4					e enema	•	•	•	6 65000			96666.	000000	0000		60006.6	2 2 2 2 3 4 5 5 6 5 6 6 7 7
	18.84 2.5 1.5			•	-	ъ °	•						666666			0.00.0	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
(KH) : S			•	56°6 ĕĕ666°1	6.6 66966.	6.6 66666.	•	°6 6¢\$¢6°6	6 66666 6	66666	ú 66666°6	6 66666.6	66666		1.00000	0000000	*****	, anala
CAPACITY ()	12.54		66666'6 66	•	•	•	6.6 66866.	6.6 66666.	. 6 66666	.6 66666.6	.6 6666.6	6 66666.6	•	66666.6	1.00000	0.0000.0	66666.6	0,0000,1
_	KWh/day 4 4 2.2	2.5	25 9.9999	66666.6 00	1.00000	.00001 9.99999	. 67740 9.99	6.6 8666¢.e	1.00000 9.9	1.00000 9.9	.6 00100.	.18579 9.	,13555 9.	.00024 9	,28502	.71498	éé666°6	•0000
is) :	DITTY FACTORS & KWh/day	3.3	52÷10. 00	00000. 00	*0000° 001		. 00000°	.00002	0.00000 1.0	00000	00000	. 00000	. 00000	00000.	00000	1.00000	.00002	0 0000.
8.6 1 1 1000. (SO. HETER IENCY (%)	3.1		KH=.505	KH=.572	KII*.596	KH#.554	КВ=.459	KH*.340	KH=.428	KH=.422	KH508	KH=.457	KH=.478	KH*.554		311.171	ANKUAL LOLP MAXIHUMS 0.0	ANNUME LOSTE [1] [1] [1] [1] [1] [1] [1] [1] [1] [1]
ILATITUDE: 8.6 TILT ANGLE: 8.6 IOAD (WATTS): 1000. ARBAY AREA (SO. HETERS): ARRAY EFFCIENCY (%): 10.0 RATTERY PFFICIENCY (%): 75.0	BATTERY	A OF DAYS	ž	FEB KH	HAR KI	APR	MAY	JUN	JUL	AUG	938	ţ	MON	DEC	ANNUAL AVG. LOLP 0.0	AMMUAL AVAILAL 0.0	ANNUAL IX XAXIHUMS 0.0	AMMIAL. 14 [1] [1] [1] [4] [4] [5]

[

			6.0
			*
			(KWh)
			CAPACITY
		3.5	ARRAY AREA (SO: 70:10.0) ARRAY EFFICIENCY (%): 10.0 ARRAY EFFICIENCY (%): 75.0 BATTERY CAPACITY (KWh): 6.0
			10.0
B, PAN	. e.	1000.	
ITY : ALBROOK A B, PAN	ATITUDE : 8.6	LOAD (WATTS) : 1000.	ARRAY AREA (SO. TALENCY (1): 10.0
ITY :	LATITUE	OVD (F	ARRAY I

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66666°6 66666°6
66666°6 66666°6

CITY: ALMERIA, SPAIN
LATITUDE: 37.0
TILT ARKIE: 37.0
LOAD (WATTS): 2000.
ARMAY AREA (SO. METERS): 60.0
ARRAY EFPCIENCY (%): 10.0
BATTERY EFPCIENCY (%): 75.0 BATTERY CAFACITY (kWh): 20.0

	100.01	9.99999	9.99999	0.999.9	9.99999	9.99999	9,99999	9.9999	9.9999	9.99999	9.9999	9.9999	9.99999	1.00000	0.0000	9.9999	9.9999
	75.08 36.0 .6	66666.6	9.99999	9.99999	9.9999	9.99999	9.99999	9.9999	9.99999	9.99999	9.99999	9.9999	9.99999	1.00000	0.0000	9.39999	9.9999
	50.0\$ 24.0 .8	9.99999	66666.6	1.00000	.08062	.03954	.01565	.00616	.01969	1.30000	9.99999	9.99999	9.9999	.59681	.40319	9.9999	.00616
	37.54 18.0 1.1	9.99999	.35608	.01340	.00081	.00103	.00047	.00014	.00028	.00533	.12955	1.00000	9.99999	.29226	.70774	9.9999	.00014
	25.00 12.0 1.7	.02787	.00147	.0000	.00001	₹0000.	.00002	.00000	.00001	.00005	.00065	.01452	.12612	.01423	.98577	.12612	00000
•	16.83	.00178	.00011	. 00001	.00000	.00001	. 00000	.0000.	•0000.	.00000	.00005	.00101	.00681	.00082	91666.	.00681	•0000.
	12.58	. 0001	.00001	•0000.	*0000	.0000	•0000	•0000	•0000	•0000	. 20000	.00007	.00037	.00005	5666.	.00037	•0000
BATIERI CAFACLLI	9.48	.00003	.00000	•0000.	.0000.	•0000.	•0000	•0000.	•0000	•0000	.00000	.00002	.00008	.00001	66666.	80060.	•0000.
75.0 BAT	RS & kWh/day 6.3% 3.0 6.7	.00001	.0000.	₩0000.	•0000	•0000	•0000.	*0000	.0000	•0000	•0000	.00001	.00002	00200.	1.00000	.00002	•0000
BATTERY EFFICIENCY (V) :	BUTY FACTORS 4 3.1% 5 1.5 3 1.5 13.3 6.	000000	00000.	000000.	.00000	00000.	.00000	00000.	.00000	00000.	00000.	39	.00000	00000.	1.00000	. 00000	00000
RY EFFICI	TTERY PACITY DAYS	Кн*.537	KH568	KH=.590	KH602	XH*.586	KH*,595	КН614	KH=.611	KH=.589	кн570	KH539	KH514	ANKUAL AVG. LOLP 0.0	ANNUAL Availability 0.0	ANNUAL LOLP Haximums 0.0	ANNUAL LOLP HIMIMUMS 0.0
HATTE	10 p	NAC	FEB	HAR	APR	МАХ	JUN	JUL	AUG	SEP	8	N S	230	ANNUAL AVG. L	AVA	ARA	ANN

	109.0% 24.0 1.5	60000 0	gracó.o	6000000		000000	0.0000	00000 b	C	000000	0000000	00000.0	00000	1.0001	ນະນະນີ ບ	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	00001.0
	75.03 18.0 1.0	00000	0 0 0 0 0 0 6	นอบบบ•์บ	icock.	.03642	, 06564	.07,22	.01416		00000	00000.6	0,000	, 41564	55.4PF.	00000.0	56100°
	50.01 12.0 2.1	ō666°6	.03532	.000.	,00000	00660.	•0006.	•0000.	•0000.	.00000	.00623	1,00000	60066.6	.25347	.74653	0000000	• 0000
	37.5% 9.0 3.9	.00543	.00002	*0000	•000u·	•0000.	*0000.	•0000.	•0000.	•0000.	.90001	.00147	.11521	.01018	. 08087	.11521	• c c c
	25.0% 6.0 5.8	.00000	•0000.	*0060*	•0000.	.0000	•0000.	*0000.	.0000.	*0000	*0000	00000.	.00004	.00000	1.00000	. 20004	:
1 35.0	18.8% 4.5 7.8	.0000	*0000.	*0000	.0000.	*000u*	*0000*	•0000.	*0000*	.0000	*0000.	•0000.	*0000.	*0000*	1.00000	•0000	:
ITY (xWb)	12.5 4 3.0 11.7	.0000	*0000.	*0000.	*0000	*0000	*0000	+0000.	*0000.	.0000.	*0000	*0000.	*0000	*0000	1.00000	*0000*	
D.O RATTERY CAPACITY (XWh)	/dav 9.48 2.2 15.6	*0000*	*0000.	*0000°	*0000	*0000.	*0000*	*0000	*0000*	*0000	.0000	•0000.	*0000.	*0000	1.00000	•0000.	
₹ .	CORS 6 kWh/dav 6.3% 1.5 23.3	*0000*	*0000	*0000	•0000	€0000.	*0000°	*0000*	*0000*	*0000.	•0000.	*0000*	*0000*	*0000	1.00000	•0000.	
LATITUDE: 37.0 LATITUDE: 37.0 LADD (MATTS): 3000. LADD (MATTS): 1000. ARRNY AREA (SQ. METERS): 4 ARRAY EFFICIENCY (%): 10.0	3.1% 6.7 1.1% 1.1% 1.1% 1.1% 1.1% 1.1% 1.1% 1.	.00000	.00000	00000.	.00040	.00000	.00000	00000.	.00000	99,00000	00000.	39	14	00000.	1.00000	. 00000	
CITY : ALMERTA, SPAIN LATITUDE : 37.0 LOAD (WATTS) : 1000. ARDAY AREA (SQ. METERS) ARRAY EFFICIENCY (%) : ANTTERY EFFICIENCY (%) :	BATTERY CAPACITY OF DAYS	KH×.537	КН°.568	KHr.590	KH=,602	KH≈.586	KH:,595	KH=,614	Ki:=.611	KH=,58	КН=.570	KH=.539	Kri=.51	ANNUAL AVG. LOLP 0.0	ANNUAL AVAILABILITY 0.0	ANNUAL LOLP MAXIMUMS 0.0	ANNUAL LOLP
CITY LATIT TILT LOAD ARRAY ARRAY	# OF GE	JAN	F58	MAR	APR	MAY	JUN	JUL	AUG	SEP	00	202	DFC	ANNUAL AVG. L	AWNUAL AVATLAI 0.0	ANN	ANN

CITY : ALMERIA, SPAIN
LATITUDE : 37.0
TILT ANGLE : 37.0
LOAD (WATTS) : 2000.
ARRAY AREA (SO. METERS) : 13.0
ARRAY EFFICIENCY (1) : 10.0
BATTERY EFFICIENCY (4) : 75.0 BATTERY CAPACITY (4Mh) :

<u>.</u>

100.00	7	9.9999	66666.3	9.99999	9.99999	9.99999	96666.6	9.99999	9.9999	9.9999	9.9999	9.99999	9.9999	1.0000	. 4. 00006	9.9999	9.9999
75.04		9.9999	9.9999	9.9999	9.9999	9.99999	9.99999	9.9999	9.9999	9.99999	9.9999	9.99999	9.9999	1.00000	00000	9.9999	9.9999
50.04	7	9.9999	66666.6	96666.6	9.9999	9.69999	9.99999	9,9999	66666.6	9.99999	66666.6	9.9999	9.99999	1.00000	0.000.p	9.9999	666666
37.54		9.99999	9.99999	9.99999	9.99999	999999	9.99999	9,9999	9,99999	9.99999	9.99999	9.9999	9.99999	1.00000	0,0000	9.9999	9.9999
25.01	7	9,99999	9.9999	9,99999	9,99999	9.99999	9.99999	9.99999	9,99999	9.99999	66666.6	9.99999	9.9999	1.00000	0.0000	9.9999	9.9999
16.8	. ·	9.9999	9.9999	9.99999	9.9999	9.99999	9.99999	9.9999	9.99999	9.99999	9.99999	9.9999	9,9999	1.00000	0.0000	9.9999	9.9999
12.50		9.99999	9.9999	9.99999	1.00000	.44115	.12301	.03055	.3122	96166.6	9.99999	9,99999	9.9999	.74383	.25617	9.9999	.05055
/dny 9.41		9.9999	1.00000	.15789	.00379	.00318	.00130	.00040	.00105	.04373	1.00000	9.9999	9.9999	.43428	.56572	9.9999	.00040
TORS & KKh/day	1.7	.12910	.00416	.00016	, 00002	.00005	.00007	00000	.00001	80000	.00168	.05640	.96257	.09619	.90381	.96257	00000.
DUTY FACTORS	3.3	.00012	.00001	. 00000	.00000	. 00000	.00000	00000.	.00000	00000.	. 00000	.00007	.00048	90000	19994	.0004	00000.
Battery Capacity	OF DAYS	KH*.537	KH".568	KH*.590	KH*.602	KII*.586	KH595	KH614	KH611	KH*, 589	KB=.570	KH539	KH=,51	ANNUAL AVG. LOLP 0.0	ANNUAL AVAILABILITY 0.0	ANNUAL LOLP Maximums 0.0	ANNUAL LOLP Minimums 0.0
ប្	4 0	JAN	728	¥	APR	MAY	JUN	JUL	AUG	SEP	Ş	¥04	DEC	ANNUAL AVG. EC	ANMUAL AVAILAI 0.0	ANKU	ANNE

14 1 1 2 2 3 miles

	100.04	.2	60600 6	, 6090n			ocooe 6	00000	6 0000	6666°6	0,000,0	0000000	00000	B UCUÓ. L	000000	1.00.09	0.0000		(0000)
	75.04		ხ სახხნ *ს	, cubbb b			60606 0	600ú6*6	66666.6	66666*6	66666*6	abbób*6	0 0 0 0 6 ° 6	p	bece o . e	1,09990	0.0000		6,000.0
	50.04	₹.	ს სხიბს ს	800000		ú6066°0	000000	9.9999	0 666666	66666.6	64666*6	6.0000	6066666	66666.6	0.000	1.00000	0,0000,0	60000	00000.0
	37.58	e. o.e.	ր 66666.6			66666 6	56656°6	66666.6	66bb6*6	66666.6	66556*6	60666.6	66066*6	66666° 6	66000.0	1.00000	0.00000	00000.0	9,00999
	25.04	0.	6 66666.6		666666	, b6666666	66666.6	66666*6	66666.6	66666.6	66666.6	66666.6	9.99999	66666.6	ģe666°6	1.00000	0.0000	60606°6	66666.6
5.0	18.81	2:1	6 66666		6 56666*6	6 66666.6	66666*	66666.6	66666.6	66666.6	9.99999	66686.6	66666*6	9.99999	66600.6	1,00000	0.0000	66666.6	06600 6
Y (KWh) :		3.0		66666	6 66666.6	6 66666 6	66666*6	66666.6	66666.6	9,99999	66666.6	ō6666°6	9.99999	66666.6	66666 66	1.00000	0.0000	66666 6	ó6666° é
BATTERY CAPACITY	, *	2.7	•	6 66666.6	6 66666.	6 66666° b	.23933	.02200	\$6200.	.00055	76800.	66666.6	66666.6	66666.6	66566.6	.60615	۱۹ ۱۹ ۱۹ ۱۹	66066.6	.0005
	DUTY FACTORS & KWh/day	6.1 1.5 1.5		9.99999	.02055 9	6 ≯0000°	*0000	*0000	•0000	•0000	*0000.	.00001	.00311	1.00000	9.99999	.25198	.74802	91919	. 0000
ARRAY EFFICIENCY (*) : 10:0	UTY FACTOR	3.1		.6 00000	00000	00000		.00000	00000	00000				•	· 🕶 ·	00000	1.00000	10000.	.00000
ARRAY EFFICIENCY (V)	0 40	. E	YS XII- 517	•	KII=.568	KH=.590	KH=.602	KII=.586	KH=.595	ки».614	КИ611	KH=.589	KH=.570	KH=.539	Kil=.51	ANNUAL AVG. LOLP 0.0	ANNUAL AVAILABILITY 0.0	ANNUAL LOLP MAXIMUMS 0.0	ARNUAL LOLP MINIMUMS 0.0
ARRAY E	TANALIAN	CAPACITY	1 OF DAYS	NA C	FEB	HAR	APR	HAY	NOC	306	AUG	SEP	00	NON	230	ANNUJ AVG.	ANNUAL AVAILA 0.	ANNU	AUNU

CITY: ALMERIA, SPAIN
LATITUDE: 37.0
TILT ANGLE: 37.0
TILT ANGLE: 37.0
ARRAY AREA (50, HITERS): 3.5
ARRAY EFFICIENCY (4): 10.0
DATTERY EFFICIENCY (4): 75.0 BATTERY CAPACITY (4Mh):

### 17.54 15.54 18.84 4.55 17.54 18.84 4.55 1.0 1.0 ### 1.1	75.00	12.0 18.0 24.9		ພາກລອຸດ ກາດຂອງ ຄຸນຄວາມຄຸນ	ບວນວໍດີ ດໍ່ ອິນຊະນະ ດ ີ ວິດີລັດ ຕົ	ຈນ່ນໍດ ວ ້ນ ພວນຈນໍຈ ຍນວັດສໍຣ	οσούο υ συνού ο ουδύδο	ວະວ່ານ ການຄວາວ ພ້ອຍຄວາມ	ນບ່ອນບໍ່ດີ ບໍ່ນານາດທົ່ນ ປະສານເຄື່ອ	uu 1000 10 10000 10 10 10 10 10 10 10 10 1	ucuus'o vervo'u opodo'b	acceció dedevió esestés		a a a a a a a a a a a a a a a a a a a	ubuto'b boútt'b budúb'b	1.00000 1.000000 1.00000	ດ.ງລຸດຕຸດ ດ.ຄອຄອກ ລ.ຄວຕເກ	
01TY FACTORS & kWh/day 3.14 6.34 7. 1.5 2.2 3.0 4.5 8.0 0.00001 9.999999	37.54	0.6	•				66666.6	06000	6.606.6	60666.6	66666.6	6600 <i>6</i> • 0	66666*6	60666.6	66666 8	1.00000	0.0000	6
01TY FACTORS & kWh/day 3.14 6.34 7.2 2.2 3.0 8.0 8.0 17 7.00101 9.99999 9.99999 9.99999 9. 999999 9.99999 9.99999 9.99999 9. 902 000000 9.999999 9.99999 9.99999 9.99999 9. 903 000000 0.00136 9.99999 9.99999 9.99999 9. 900000 0.00001 9.99999 9.99999 9.99999 9. 900000 0.00000 9.99999 9.99999 9.99999 9.99999 9.99999 9.999999	25.08	0.9	0.7	66006.6	66666.6	66666.6	9.99999	66666.6	66656*6	66566*6	o6666*6	စ်စ်စ်စ်စ် စ	6666666	6666666	66666*6	1.00000	0.00000	9
0.11 FACTORS & kWh/day 1.13 2.2 8.0 1.0 1.5 1.5 6.3% 2.2 2.2 8.0 1.0 1.0 1.0 1.0 1.0 1.0 1.0	9	18.61	F:1	66666*6	66666.6	66666*6	66666*6	66666*6	66666.6	66666.6	6606616	66666.6	ö6666*6	66666.6	66666.6	1.00000	0.00000	9
1.14 6.3% 1.14 6.3% 1.5 4.0 1.5 4.0 1.5 6.0% 1.5 4.0 1.6 0.000 1.6 0.0000 1.6 0.0000 1.6 0.0000 1.6 0.0000 1.7 0.0000 1.8 0.00	:	3.0	2.0	66666.6	66666.6	66666'6	9.99999	66666*6	66666666	60666.6	60666.6	66066.6	66666	66666.	9,99999	1.00000	0.00000	
11	day	9.4	. 2.7	66666.6	9.99999	66666.6	9,99999	66666.6	66666*6	9,99999	66666.6	66666.6	66666.6	66666.6	66666.6	1.00000	0.00000	
			4.0	96666.6	9.99999	66666.6	.00136	.00013	.00001	•0000.	.00002	9.99999	66666*6	9.99999	66666.6	.58346	.41654	
TTERY PACITY DA/S KH=.53 KH=.56 KH=.59 KH=.59 KH=.59 KH=.59 KH=.59 WAL UAL UAL UAL UAL UAL UAL UAL	DUTY FACT	3.19	0.8	•	•		•			•		_		•	•	.00007	.99493	
BAANNA ANNA ANNA ANNA ANNA ANNA ANNA AN	TTERY	VPACITY	OF DA IS	КН537	KB=.56	KH=,591	K11≈.60	KH=.58	KH=.59	Kii= , 6]	KH=.6]					AHNUAL Avg. Lolp 0.0	ANNUAL AVAILABILITY 0.0	ANNUAL LOLP MAXIMUMS

CITY : SAN ANTONIO, TEX
LATITUDE : 29.5
TILT ANGLE : 29.5
TABLI HAPTS : 2000.
ARAN EREA (S) . HEDERS : 60.0
ARAN EFFICIENCY (%) : 10.0
BATTERY EFFICIENCY (%) : 75.0 BATTERY CAPACITY (kWh) : 20.0

BATTERY	BUTY FACTORS	TORS & KWh/dav	/45%	12.54	18.81	25.04	37.58	50.01	75.04	100.00
_	J. 7	 		3.0	2.2	1.7	1.1			•
٠,	00001	.00003	.00010	.00041	.00602	.08551	9.99999	9.99999	9.9999	9.9999
	00000	.00001	.00003	.00005	.00068	.00814	1.00000	9.9999	9.9999	9.9999
KH=.522	00000	.00000	.00000	.00001	.00012	.00130	17927	66666.6	9.9999	9.9999
KH502	00000	00000.	.00001	.00003	.00019	.00158	.08443	9.9999	9.9999	9.99999
KH543	.00000	*0000.	00000	00000	.00003	.00020	.00727	.45250	9.99999	9.99999
KH=.576	. 00000	*0000*	*0000	*0000	00000	.00003	.00106	17750.	9.9999	9.99999
	КН=.599 .00000	•0000	*0000	•0000	*0000	.00001	. 00027	.01853	9.9999	9.99999
	KH~.583	*0000.	.0000	•0000.	. 00000	.00002	.00114	. 10563	9.99999	9.9999
	KH551	*0000.	*0000	00000	.00002	.00020	.02133	1.00000	9.99999	9.9999
	КН543 .00000	•0000.	00000.	.00001	.00007	.00093	.16107	9.99999	9.9999	9.9999
	00000.	.00001	.00003	.00013	.00180	.02439	9.99999	9.9999	9.9999	9.9999
	KH481	.00003	.00010	.00044	.00711	.11113	9.9999	9.9999	9.9999	9.99999
	.00000	. 0066 j	.00002	.00009	.00134	.01945	.37132	.71953	1.00000	1.00000
	1.0000	¥6666.	16666.	19991	99866.	.91055	.62868	. 28047	0.0000	0,0000
	.00001	.00003	.00010	. 00044	.00711	.11113	9.95999	9.9999	9.9999	9.9999
	.00060	*0000.	.0000	•0000.	•0000	.00001	.00027	.01653	9.9999	9.9999

CITY: SAW ANTOWIO, TEX LATITUDE: 29.5 TILT ANGLE: 29.5 LOAD WATERS): 40.0 ARMAY AREA (SO, PETERS): 40.0 ARMAY EFFICIENCY (%): 10.0 MATTHEY EFFICIENCY (%): 75.0 MATTHEY CAPACITY (KKH): 35.0

24.0 1.5	6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6. 6	64666.6	9.99949	6666.6	9.99999	66666.6	66666.6	66666 t	666 6 6.6	9.99999	9.99999	9.99499	1.00000	0.0000	9.99999	9.9999
75.0% 18.0 1.9	i i666i*6	66666° ó	5 06566.6	±6666.6	1.00000	.10217	.01457	.52373	66666.6	9.99999	9.9999	9.9999	.80337	. 19663	9.9999	.01457
50.0 3 12.0 2.9	66666*	.78783	.01202	.00410	90000	00000	*0000	00000	.00029	.00943	66666.6	66666.6	.31781	.68219	9.9999	.0000.
37.5 \$ 9.0 3.9	.04387	.00046	.00002	.00002	*0000	.0000	•0000.	•0000.	.0000.	.00001	.00380	.07960	.01065	.98935	.07960	*0000*
75.0% 6.0 8.8	.00003	•0000.	*0000*	•0000.	*0000	•0000.	•0000.	•0000.	•0000.	•0000.	.00000	.00004	.00001	66.66.	.00004	*0000
18. 8. 7. 5.	00000.	.0000	•0000	•0000	•0000•	*000u.	*0000	*0000.	•0000.	.0000	.0000	.00000	•0000.	1.00000	000070.	•0000.
3.0	.0000.	.0000.	*0000*	*0000.	.0000	•0000.	•0000.	*6000.	*0000*	*0000	*0000	*0000	•0000.	1.00000	•0000.	•0000-
184 2.2 15.6	.0000	•0000.	*0000.	*0000*	*0000°	•0000.	•0000.	•0000	•0000	*0000	•0000	•0000.	*0000	1.00000	•0000•	*0000*
HS & KWh/dav 6.3% 1.5 23.3	•0000.	.0000	•0000.	*0000	•0000	•0000.	*0000	*0000.	•0000	•0000	•0000.	•0000	•0000.	1.00000	•0000.	•0000•
3.14 46.7 2	00000.	.00000	.00000	00000	00000	00000	.00000	.00000	00000.	3.00000	.00000	000000	00000	1.00000	. 00000	00000
HATTINY CAPACITY F DAYS	K1=.478	KH=.508	KII».522	KH502	KH*.543	KH576	KH 599	KH=.583	KH=.551	KH=.543	KH=.498	XH=.481	AL LOLP 0.0	411.17	ANNUAL LOLP MAXITUMS 0.0	AENUAL LOLP Kinimums 0.0
HAT CAP	JAN	FER	HAR	APR	нах	JUN	JUL	AUG	SEP	5	NON	DEC	ANNUAL AVG. LOLP 0.0	AVAILA 0.0	ANNUAL LA MAXITTUMS 0.0	AEMUAL LA Finimums 0.0

CITY: SAN ANTONIO, TEX
LATITUDE: 29.5
TILT ANGLE: 29.5
TILT ANGLE: 29.5
ANALY MARTES: 2000.
ANALY MARAY EFFICIENCY (%): 10.0
BATTERY EFFICIENCY (%): 10.0
BATTERY EFFICIENCY (%): 75.0
BATTERY CAPACITY (kWh): 5.0

	100.04	9.99999	9.99999	9.9999	9.99999	9.99999	9.99999	9.9999	66666.6	9.99999	9.9999	9.99999	9.9999	1.00000	00000.0	9,9999	9.9999
	36.0	9.39999	9.99999	9.99999	9.99999	9.99999	9.99999	9.99999	66666.6	9.99999	9.9999	9.9999	9.99999	1.00000	0.0000	9.9999	9.9999
	\$0.0 % 24.0	6.666.6	9.9999	9.99999	9.9999	6.666.6	66666.5	66666.6	9.99949	9.9999	6:666.6	9.9999	9.99999	1.00000	0,000.0	9.9999	9.9999
	37.54 18.0	9.99999	9.99999	66666°	6666°i	9.94999	66666.6	9.9999	9.99999	9.9999	9.99999	6:666.6	9.9999	1.00000	00000.0	9.9999	9.9999
	25.08 12.0	66666.6	66366.6	9.9999	66666.6	66666.6	66666.6	9.9999	6.99999	6.9999	66666.6	9.9999	9.9999	1.00000	0.0000.0	9.9999	9.9999
	16.84 9.0 3.6	9.9999	9.9999	9.99999	9.9999	9.99999	6666676	9.9999	9.9999	9.9999	9.9999	9.9999	9.91999	1.00000	0.00000	9.9999	9.95599
	12.5% 6.0	9.9999	9.9999	9.9999	9.99999	1.00000	1.00000	. 29140	1.00000	9.9999	9.9999	9.9999	9.99599	.94095	.05905	9.9999	.: +140
,	9.4. 9.4. 1.3	9.9999	9.9999	1.00000	.69290	.03029	.00390	96000.	.00526	.19852	1.00000	9.99999	9.9999	.57765	.42235	9.9999	96000.
77.C 0.C/	3.14 EACTORS & kWh/dav 3.14 5.31 3.3 3.0	.46227	.02580	.00322	.00310	.00023	.00004	.00001	. 90003	.00040	.00239	.09732		.10865	. 89115	16117.	.00001
MCY (%) :	DOTY FACT 3.10 1.5 3.3	.00049	90000.	2.00001	.00002	00000.	. 00000	00000.	. 00000	.00000	13	.00015	.00055	.00011	.9989	. 00055	.0000
BATTERY EFFICIENCY (%) : /3.U	BATTERY CAPACITY)F DAYS	KH476	KH=.508	KH522	KH*.502	KH*.543	KH=.576	KH=.599	KH583	KH551	KB=.543	KH 498	KH+. 481	ANG. LOLP	AMMUAL Availability 0.0	ANNUAL LOGP MAXIMUMS 0.0	AMEGAL LOLP MINIMUMS 0.0
BATTER	BAT CAP	JAK	FE8	HAR	APR	MAY	200	JUL	AUG	42 8	5	3	DEC	ANMUAL AVG. L	ANNUAL AVAILA 0.	ANDEL MAX I	AMM

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CITY: SAN ANTONIO, TEX
LATITUDE: 29.5
TILT AUGLE: 29.5
LOAD (WATTS): 1000.
ARMAY ARTS 15. MATTERS): 5.0
ARMAY EFFICIENCY (%): 10.0
BATTERY EFFICIENCY (%): 75.0 PATTERY CAPACITY (KWIL): 5.0

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TERY effici en nattery d	RATTERY EFFICIENCY (V) : 75- NATTERY DUTY FACTORS	5 2	Wh/dav			25.09	37.54	\$0.04	15.01	100.00
)	3.1	6.31	9.48	12.54 3.0		6.0.4 6.0	0.6	12.0	18.0	24.0
	6.3	. E	2.5	1.7	1.1	۴.	ų.	•	?	•
	00003	66666.6	66666.6	66666.6	66666.6	66666.6	66666.6	66666.6	60666.6	p#66p.6
	00000	.60591	66606.6	66666.0	66666.6	9.99999	66666.6	9.99999	66666.6	66666°6
	00000	.00644	66666.6	66666.6	66666.6	6666°6	66666.6	9.99999	66666.6	66666.6
KH502	00000	.00205	9.99999	9.99999	66666.6	66666.6	66666.6	66666.6	66666.6	66666.6
KH543	00000	.00002	1.00000	66066.6	66666.6	9.99999	66666 66	66666.5	66666.6	66666.6
KH576	.00000	•0000.	.06654	66666.6	66666.6	66666.6	66655*6	66666.6	96666.6	\$6666°6
KH=.599	.00000	*0000	00800	9.99999	9,99999	9.99999	66666.6	9.99999	9.99999	9.99999
KH583	. 00000	*0000	.39434	66666.6	66666.6	9.99999	66666.6	9.99999	9.9999	9.99999
KH551	.00000	.00011	9.99999	9.99999	66666.6	60666*6	6.656.6	9.99999	9.99999	9.99999
KH543	. 00000	.00492	9.9999	9.99999	9.9999	9.99999	9.99999	66666.6	9.9999	9.95999
XH=.498	00000	9.9999	9.9999	9,99999	9.9999	9.99999	9.99999	9.99999	9.99999	9.9999
KH=.461	.00001	9.9999	9.9999	66666.6	9.9999	9.99999	9.9999	9.9999	9.99999	9.9999
	.00000	.30162	78907.	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
	1.00000	. 69838	. 21093	0.00000	0.0000	0.0000	0,00000	0.0000	0.0000	0.00000
	.00001	9.9999	9.9999	9.9999	9.9999	9.9999	9.99999	9.9999	66666.6	9.99999
	. 00000	•0000	00800	9.9999	66066.6	9.9999	9.99499	9.9999	9.9999	9.9999

CITY: SAN ARTONIO, TEX LATITUDE: 29.5 TILT ANGLE: 29.5 LOAD (MATTS): 1000. LOAD MARTS): 3.5 ARRAY EFFICIENCY (1): 10.0 NATTERY CAPACITY (NUM): 6.0

	100.01	e :	6666°6	66666.6	66666.0	66666.6	6606ú 6	\$6666° á	9.99999	9.99999	9.9999	66666.6	9.99999	9.99999	1.00000	0.00000	9.9999	9,9999
	75.01	: .	66666.6	66666.6	66666.6	9.99499	66666.6	9.99999	9.99999	9.99999	9.99999	66666.6	66666.6	66666.6	1.00000	0.0000	é666°6	9.9999
	50.04	,	66666*6	66666.6	9.99999	66666.6	9.99999	65666.6	66666.6	66666.6	66666.6	9.99999	9.99999	9.99999	1.00000	0.0000.0	9.9999	9.9999
	37.58		66666.6	66666.6	66666.6	9.99999	66666.6	66666.6	66666.6	6666666	66666.6	66666.6	9.99999	65666.6	1.00000	0.00000	9.9999	9.9999
	25.01	1.0	66660.6	66066.6	66666.6	66666.6	66666°6	66666.6	9.99999	66666.6	66666*6	66666.6	66666.6	66666.6	1.00000	0.0000.0	9,99999	9.99999
	18.84	 	66666° 6	66666.6	66666.6	ō5666°6	66666.6	9.99999	9.99999	9.99999	666666	66666.6	65666.6	9.99999	1.00000	0.0000	9.9999	9.9999
	12.50	7.0	66666.6	65666.6	6é666*6	6666666	6,999 P	9.99999	66666.6	9.99999	66666.6	9.9999	9.59999	9,99999	1.00000	0.0000	9.9999	9.99999
THE CALL	38V 9.48	2.2	66666.6	66666.6	9,99999	66666.6	66666.6	66666.6	9.99999	9.99999	9.99999	66666.6	66666*6	9.99999	1.00000	0.00000	9.9999	9.9999
37100 0.07	DUTY FACTORS & kWh/day	5.0	66666.6	66666.	66666.6	9.99999	.12735	.00042	.00002	.00287	9.99999	9.99999	9.99999	9.99999	.67755	.32245	9.9999	.00002
HATTINY EFFICIENCY (*)	DUTY FACT	8.0	.00028	00000.	.00000	2.00000	3.00000	00000.	00000.	.00000	. 00000	.00000	.00001	.00060	.00007	.99993	.00060	.00000
KY EFFICIA	BATTERY	OF DAYS	KH=.478	KH=.508	KH=.522	KH=.502	KII+.543	КН≖.576	XB*.599	KH=.583	KH=.551	KH*.543	KH=.498	KH*.401	AMMUAL AVG. LOLP 0.0	AMNUAL AVAILABILITY 0.0	ANMUAL LOLP MAXIMUMS 0.0	ARMUAL LOLP MINIMUMS 0.0
INT	BAC	- 40 -	JEN	FER	HAR	APA	HAY	NOC	JUL	AUG	SEP	9C4	NON NO	DEC	ANMUAL AVG. LA	ARNUAL AVAILA 0.0	ANKU	A 1994

CITY: SPOUL, KORTA
LATITUDE: 37.6
TILT ANGLE: 31.6
LOAD (WATES): 2000.
ARRAY EFFICIENCY (%): 10.0
RATTERY EFFICIENCY (%): 75

	_	•							
5 13 KH-, 535									
535		3.0		6.0	25.04 12.0	37.50	24.0	75.01	
		•	3	7.7					0 T
	10000 . 00000	.00003	.00013	A1500.	77000				
KH526						1.99994	9.99999	9.99999	9.99999
.00000	10000. 000	. 00002	.00008	.00105	.01261	-			
KH517							9.99999	9.9999	9.99999
00000	00000 . 000	.00001	₹0000.	.00041	.00434	7637			
KH505							7.54999	1.95999	9.94999
00000	.00000	.00002	.00005	7.000.	97000				
KH*.510			1		64700.	8.111.	9.9999	9.99999	9.9999
00000	10000. 00	.00002	10000	7000					
KH506					. 00157	.03396	1.00000	9.99999	9.99999
. 00000	00 .00001	.00003	20000	0000	•				
KH=.465				. 05030	.00166	.02971	1.00000	9.99999	9.99999
. 0000	. 000005	. 00010	2000		,				
KH475		•			.00707	.14443	1.00000	9.99999	9.9999
00000	.00003	#0000°		:					
KH=.509	•		7000	. 00113	.00687	.20545	66666.6	9.99999	9.99999
.00000	000000.	.00001	70000						
KH531				66000.	.00354	.35034	66666.6	9.99999	9.99999
. 00000	000000. 0	.00001	*0000	2000	,				
KH501				•	. 100517	1.00000	9.49999	9.99999	9.99999
.0000	1 .00003	60000	.00037	99500			,		
KH498						7.73599	9.99999	9.99999	9.99999
.00001	1 .00004	.00016	47000	277.0					
					.30713	9.99999	9.99999	9.99999	9.99999
. 00000	.00002	.00005	71000.	31.000		•			
annual Avai <u>lab</u> ility					60650.	. 55321	1.00000	1.00060	1.00000
1.00000	16666.	.99995	. 99983	99766					
					16096	.44679	0,0000.0	0.0000	0.0000
.00001	.00005	.00016	978	01460					
					. 30/13	9.9999	9.9999	9.99999	9.9999
.00000	00000	.00001	10000	.00026	.00157	.02671			

CITY : SPOUL, KOPEA
LATITUDE : 37.6
LOAD (WATERS): 40.0
AKMAY AREA (%): 10.0
BATTERY EFFICIENCY (%): 10.0
BATTERY EFFICIENCY (%): 75.0 BATTERY CAPACITY (KWH): 35.0

	100.01	1.5	9.9999	66666.6	6.99999	66.66.6	66666.6	9.99999	9.99999	9.9999	9.99999	66466.6	9,9999	9.9999	1.00000	0.0000	9.9999	9.9999
	75.04	1.9	9.99949	66666.6	66666.6	9.99999	9.99999	1.00000	9.99999	9.99999	9.9999	66666.6	66566.6	66666.6	1.00000	0.00003	9.9999	1.00000
	50.01	5.9	66666.6	1.00000	.13624	.00726	.00118	.00102	.01463	.02303	.04155	.29411	9.99999	9.99999	.37658	.62342	9.9999	.00122
	37.54		.00807	.00105	.00014	.00005	.00002	.00003	.00032	.00026	.0000	.00021	.04346	63989	.05780	.94220	.63989	.00002
	25.04	. w	00000	00000	•0000.	•0000	•0000	•0000.	.00001	.00000	.0000.	.0000	.00003	41000.	.00002	R6666.	.00014	•0000-
	18.85	7.00	*0000	.0000.	•0000.	•0000.	*0000.	*0000.	00000.	•0000.	•0000	.0000.	00000.	00000.	•0000.	1.00000	00000	*0000.
	12.58	3.0	*0000	.0000	*0000.	*0000.	•0000.	.0000	•0000.	*0000.	*0000.	*0000.	•0000.	*0000	*0000.	3.00006	•0000	•0000.
THE PARTY OF THE	9.48	2.2 15.6	•0000.	•00.0.	.0000	*0000.	*0000*	.0000	•0000.	•0000.	•0000.	.0000	•0000.	*0000.	*0000	1.00000	*0000.	*0000
0.67	DUTY FACTORS & KWh/dav	23.3	•0000	*0000	•0000	*0000	•0000	•0000	•0000.	•0000	•0000	*0000.	*0000.	,0000°.	•0000	1.00000	*0000	•0000
BATTERE EFFICIENCE (V) :	DUTY PACT	46.7	.00000	00000.	00000.	00000.	00000.	00000.	.00000	.00000	000000.	31,00000	00000.	00000.	.00000	1.00000	00000.	00000
ENY EPPICE	BATTERY CAPACITY	OF DAYS	XII535	KII=,526	KH*.517	KH*.505	KH510	KH=.506	KH*, 465	KH=.475	KH=.509	KH*.531	KH=,501	XH=,498	IAL LOLP 0.0	ANNUAL AVAILABILITY 0.0	AHMUAL LOLP MAXIMUMS 0.0	ANNUAL LOLP MINIMUMS 0.0
NATT.	a o	• OF	JAN	FEB	11AR	APA	нах	NOC	JUL	AUG	23 55	Ş	Š	JAG	ANNUAL AVG. L	ANMUAL AVAILA 0.	AUM	ANM KINI

6,99999 25.01 12.0 9.9999 9.99999 6.6666.6 66666.6 66666.6 LATITUDE: 37.6
LATITUDE: 37.6
LOAD (WATTS): 2000.
LOAD (WATTS): 1000.
AHRAY AREA (SO, METERS): 13.0
ARRAY EFFICIENCY (%): 10.0
BATTERY EFFICIENCY (%): 5.0 66666.6 9.99999 9.99999 9.99999 12.5 6.0 8. 66666.6 9.99999 9.99999 9.9999 9.99999 .13272 9.99999 666666.6 .83199 9.99999 DUTY PACTORS & kWh/dey 3.1% 6.3% 9.1 1.5 3.0 . 4 .00513 .00246 .16399 .04296 .01216 .00015 .00003 KII: . 510 KH*.535 KH-.517 BATTERY CAPACITY I OF DAYS JAN

100.08 48.0

75.0% 36.0

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DEC

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CITY: SPOUL, KOREA
LATITUDE: 37.6
LATITA MIGLE: 37.6
LOAD: (MATTS): 1.000.
AKHAY AREA (SO. METERS): 5.0
AKHAY EFFICIENCY (%): 10.0
NATERY EFFICIENCY (%): 75.0 NATTERY CAPACITY (KWH): 5.0

	 	 			:					24.0
OF DAYS	6.7	3.3	2.7	1.7	1.3	. e.		4.		. 2
KII=.535	.00000	9.99999	66666.6	66666.6	66606.6	66600.6	66666.6	66666.6	66666.6	66066.6
KH=.526	. 00000	1.00000	n6ú66°6	60066.6	66666.6	66666*6	66606.6	. 66666.6	65666*6	ĕ6 0ĕ6*6
Kile. 517	. 00000	.09045	66666.6	66666.6	66686.6	66666.6	66606*6	66696*6	66966.6	9.99999
XH=.505	00000	.00385	66666°6	66666.6	66666.6	66666	6.9999	66666.6	66666.6	9.99999
КН#.510	.00000	.00054	6666666	66666.6	66006*6	66006*6	65566*6	66666.6	999999	9,99999
кн=.506	00000.	.00047	1.00000	66666.6	66666 0	66556*6	66606*6	66666.6	96666.6	66666.6
KH=.465	.00000	.00853	9.99999	9.99999	9.99999	9.99999	66666 66	9,99999	9.99999	96666.6
XH=.475	.00000	.01376	9.99999	9.99999	66666.6	9.99999	9,99999	9.99999	66666.6	6666666
KH=.509	.00000	.02506	9.99999	9.99999	9.99999	66666.6	66666.6	66666.6	66666.6	9.99999
KH=.531	.00000	.21516	9.99999	9.99999	9,99999	66666.6	9.99999	9.99999	9.99999	9.99999
KH=.501	.00001	9.99999	66666.6	9.99999	66666.6	9.99999	66666.6	66666.6	9.99999	66666.6
KB=.498	.00005	9.99999	6.6666.6	9.99999	66666.6	66666.6	9.99999	66666*6	66666.6	9.99999
ANNUAL AVG. LOLP 0.0	.00001	.36315	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1,00000
ANNUAL AVAILABILITY 0.0	66666.	.63685	0.0000	0.00000	0.00000	0.00000	0.0000	0.0000	0.0000	0.0000
ANNUAL LOCP MAXIMUHS 0.0	.00005	66666.6	9.9999	9.99999	9.99999	66666.6	9.99999	66666.6	9,99999	9.99999
ANNUAL LOSP MINIMUMS 0.0	. 00000	.00047	1.00000	9.99999	9.99999	66666.6	66666.6	9.99999	66666′6	9.99999
	KH=.515 KH=.526 KH=.505 KH=.506 KH=.506 KH=.501 KH=.501 KH=.501 LLOLP .0 LLOLP .0 LLOLP .0 LLOLP .00 .00 LLOLP .00 .00 LLOLP .00 .00 .00 .00 .00 .00 .00 .00 .00 .0	513 52 52 6 73 5 73 6 73 6 73 6 73 6 73 6 73 6 73	.515 .00000 .517 .00000 .505 .00000 .510 .00000 .509 .00000 .511 .00000 .501 .00000 .501 .00000 .501 .00000	5.55 6.00000 9.99999 9 9 9 9 9 9 9 9 9 9 9 9 9	5.55 .00000 9.99999 9.99999 .517 .00000 .09045 9.99999 .508 .00000 .00385 9.99999 .506 .00000 .00054 9.99999 .506 .00000 .00054 9.99999 .475 .00000 .00067 1.00000 .475 .00000 .01376 9.99999 .509 .00000 .11516 9.99999 .509 .60000 .31516 9.99999 .509 .60000 .36385 0.00000	5.55 .00000	51500000 1.00000 9.99999	\$575. \$600000 1,000000 9,99999		. 15.1

CITY: SEOUL, KOKEA
LATITUDE: 37.6
TILT ANGLE: 37.6
LOAD (NATTS): 1000.
ARMAY AREA (SO, METERS): 3.5
ARMAY REFICIENCY (%): 10.0
NATTENY EFFICIENCY (%): 75.0 DATTERY CAPACITY (kPh): 6.0

	160.09 24.0 .3		66566.6	66666.6	66666	66666.6	66666*6	9,9999	66666.6	66666.	66666.6	66666.6	66666.6	66666.6	1.00000	0000000	66666.6	9.99999
			_		•								6 66668*6	6 66666.6	1.00000 1	0.00000	9.99999	66666.6
	75.04 18.0		6666 6	66006 0	66666.6	66666.6	66666.6	66666.6	9.99999	9.99999	66666.6	9.99999	6.89					
	50.0% 12.0		9.99999	69999.	66066*6	. 66 8 66*6	9.99999	66666.6	66666*6	66666.6	66666.6	66666*6	9.99999	9,99999	1.00000	0.0000	66666.6	66666*
	37.58 9.0	:	66666.6	66666.6	66666.6	66666° 6	9.99999	66666.6	66666.6	666666	66666.6	66666.6	66666.6	66666.6	1.00000	0.0000	6.9999	666666
	25.00	<u>:</u>	66066.6	66666.6	66666*6	66666*6	66666*6	66666.6	66666.6	66666.6	66666.6	9.99999	66666.6	66666.6	1.00000	0.0000.0	66666*6	9.99999
•	18.8	· ·	06666 66	66666.6	9.99999	66666.6	66666.6	66666.6	6666666	9.99999	66666.6	66666.6	66666.6	66666.6	1.00000	0.0000	66666*6	9.99999
	3.0	2.0	66666.6	9.99999	9.99999	9,99999	9.99999	66666°6	66666.6	9.99999	9.99999	9.99999	9.99999	9.99999	1.00000	0.00000	9.99999	6666.6
DATTERY CAPACITY	dav 9.49 2.2	2.7	66666.6	9.99999	66666.6	66666.6	66666.6	9.99999	66666.6	9.99999	66666.6	66566.6	9.99999	9.9999	1.00000	0.00000	66666.6	9.99999
75.0	ORS & KWh/dav 6.3% 1.5	0.4	9.99999	66666.6	66666.6	66666.6	1.00000	.65919	9.99999	66666.6	66666° 6	9.99999	9.99999	9,99999	.97160	.02840	9.99999	.65919
Y (3)	DUTY FACTORS	.0.	0000	00000	00000	00000	00000	00000	00000	00000	00000	00000	.00026	•	.00102	99896.	16110.	.00000
NATTERY EFFICIENCY (4)	BATTEPY DU	DAYS	KII•.535	KII=.526	KH=.517	KH505	KH*.510	KH#.506	KH*.465	KH=.475	KH509	КН=.531	KH*.501	KH* . 498	ANNUAL AVG. LOLP 0.0	ANNUAL Availability 0.0	ANNUAL LOLP MAXIMUMS 0.0	ANNUAL LOLP Minimums 0.0
NATTER	BAT	OF D	JAN	FEB	MAR	APR	HAY	JUN	JUL	AUG	SEP	6	20 2	DEC	ANNUAL AVG. L	ANWUAL AVAILA 0.0	ANNU	ANNU

CITY: WASHINGTON DC
LATITUDE: 39.0
TILT ANGLE: 39.0
LOAD (WATTS): 2000.
ARRAY AREA (SQ. METERS): 60.0
ANHAY EFFICIENCY (%): 75.0 DATTERY CAPACITY (kWh): 70.0

BATTERY EFFICIENCY (%)	FICIENCY		: 75.0 BATT	DATTERI CAPACIJI (KWII)	II (KWII)						
BATTERY		FACTO	RS & KWh/dav	, ·	12.51	18.81	25.01	37.54	50.08	75.00	100.00
CAPACITY		= .	, o		9	0.6	12.0	0	24.0	. •.	₹.
OF DAYS	13.	13.3	6.7	7.	3.3	2.2	:	:	;		
JAN K	KH417		.00051	.00256	.01213	.23369	1.00000	9.9999	66666.6	9.99999	9.99399
FEB K	KP*.447	0000	.00013	.00050	.00198	.02496	.34862	66666.6	9.99999	9.99999	9.9999
HAR KI	кн=.460	00001	.00004	.00012	.00043	.00472	.04735	9.9999	9.99999	9.9999	9.9999
APR KI	XH=.480	00000	.00003	90000.	.00016	.00113	.00763	.32976	9.99999	9.99999	9.9999
MAY R	KH*.496	00000	.00002	₹0000	.00010	.00052	.00290	.05642	1.00000	6.666.6	9.99999
NOC X	КН∗.520	00000	.00001	.00002	.00004	.00020	.00111	.01826	.49062	9.99999	
JUL	KH⊄.509	00000	.00001	.00003	,00006	.00031	.00170	.03063	1.00000	9.99999	6-666.6
Y 9aY	жн=.499 .00	00000	.00001	.00003	.00008	.00048	.00306	.08542	1.00000	9.99399	66666.6
SEP	XH=.494 .00	00000	.00001	.00003	60000	.00082	.00734	.84055	65666.6	9.99999	66666.6
5	кн479	00001	.00003	.00011	.00038	.00477	.05250	6666.6	66666.6	9.99999	66666.6
MON	KH420	•0000	.00037	.00169	.00762	.12057	1.00000	9.99999	9,99999	9.99999	9.99999
DEC	KH383	00019	.00131	.00805	.04089	1.00000	66666.6	9.99999	9.99999	9.99999	9.9999
ANNUAL AVG. LOLP 0.0		.00004	.00021	.00110	.00533	.11601	.28933	.61359	.95755	1.00000	1.00000
ANNUAL Avaïlability 0.0		96566.	.99979	.99890	.99467	. 06399	.71065	.38641	.04245	0.0000	0.0000
AMNUAL LOLP MAXIMUMS 0.0		.00019	.00131	.00800	.04089	1.00000	9.9999	9.9999	9.9999	9.99999	9.9999
AMMUAL LOLP MIMIMUMS 0.0		00000.	.00001	. 00002	.00004	.00020	11100.	.01826	. 19062	9.9999	9.9999

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O BATTERY CAPACITY (kWh) 1 35.0 CITY: WASHINGTON DC LATITUDE: 39.0 TILT ANGLE: 39.0 LOAD (WATTS): 1000. ARRAY AREA (SO, METERS): ARRAY EFFICIENCY (%): 10.0

NATTENY EFFICIENCY	(1) : 75.0	0	ENT CAPACITY		1			;	•	100.001
UTY # 3.17	ACTORS	5 & KWh/dav 6.3% 1.5 23.3	9.44 2.2 15.6	12.50 3.0 11.7	18.81	25.04 6.0 5.8	37.58 9.6 9.6	50.04 12.0 2.9	16.0	1.5
	•		.00000	.00001	.00047	71220.	66666.6	65666.6	66666.6	66366.6
		•0000	.0000	00000	.00002	.00048	.54182	6,9999	00666.6	0666666
		•0000•	•0000	•0000.	00000.	.00003	17110.	9.99999	66666.6	66666 6
		•0000	.0000.	*0000	*0000	00000.	.00034	.04576	66666°6	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
u		*0000	•0000•	•0000.	•0000	.00000	90000.	.00305	66666°6	66666.6
		•0000.	•0000	*0000	•0000.	•0000	.00001	.00045	1.00000	66666*6
5		•0000.	•0000•	•0000°	•0000	*0000.	.00003	.00105	1.00000	6566 5*
0	. 00000	•0000	*0000	*0000	•0000	.00000	.00007	.00523	9.9999	6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6
8		•0000*	*0000	.0000	*0000.	00000.	.00035	.16712	66666*6	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
2		•0000.	•0000.	•0000	. 00000	.00003	.01517	66666.6	9.99999	9.99999
ĕ	00000	*0000	00000	.00001	.00021	.00742	65666.6	9,9999	ă6á6 6 *6	66666.6
~ ~	00000	.00000	.00001	.00007	.00482	48096	666666	o á a ó a * 6	66666.6	66666.6
ō	00000.	*0000	00000	.00001	.00046	.04259	. 29746	.51854	1.00000	1.00000
ě	1.00000	1.00000	1.00000	66666.	.99954	.95741	.70254	.48144	0.0000	0.0000
o.	.00000	00000.	. 00001	. 00007	.00482	.48096	9.9999	\$6666°	9.9499	6666°6
6	00000	•0000.	•0000.	•0000	•0000.	.0000	.00001	.00045	1.00000	9.9999

C1TY: WASHINGTON DC
1ATITUDE: 19.0
1ALT ANGLE: 39.0
1ALT ANGLE: 39.0
LOAD (WATTS): 2000.
ARRAY AREA (SO. METERS): 13.0
ARRAY EFFICIENCY (N): 10.0
ARRAY EFFICIENCY (N): 75.0 BATTERY CAPACITY (NWh): 5.0

36.0 48.0	9,9999 9.9999	9.9999 9.9999	9,9999 9,99999	•	9,99999 9,99999	99999 9.99999	9.9999 9.99999			9,9999 9,99999	•	64666.0 00000.0	1.00000 1.00000	0.0000 0.0000	9.9999 9.9999	9.9999 9.9999
2007	66666.6	9.9999	9.99999	9.99999	9.99999	9.99999	9.9999	9.99999	9.99999	9.99999	9.99999	9.9999	1.00000	0.0000	9.9999	9.9999
10.0	9.9999	9.99999	9.99999	9.99999	66666.6	9.99999	9.9999	9.9999	9.9999	9.99999	9.99999	9.9999	1.00009	0.0000	9.9999	9.9999
12.0	9.9999	9.9999	9.99999	6.99999	66666.6	66666.6	9.99999	66666.6	9,99999	66666.6	9.99999	9.9999	1,00000	0.00000	9.9999	9.9999
9.0. 0.0.	9.9999	9.9999	9.9999	9.99999	9.9999	66666.6	9.9999	9.9999	9.9999	66666.6	9.99999	9.9999	1.00000	0.0000	9.9999	9.9999
12.54	66666.6	9.9999	9.9999	9.9999	9.99999	1.00000	9,99999	9.9999	9.9999	9.9999	9.9999	9.9999	1.00000	0.0000	9.9999	1.00000
	65666.6		9.9999	1.00000	.24097	.05669	.10753	.46304	9.9999	9.9999	9.9999	9.9999	.73902	.26098	9.9999	.03669
6.34 3.0 1.7	666676			.01545	.00472	.00157	.00260	.00535	.01896	.21096	9.9999	9.9999	.36916	.63084	9.9999	.00157
BUTY FACTORS 3.1% 1.5 3.3				00015	.00000		,00005	. •	90000	.00044		3.08685	.01030	0.98970	.08685	.00003
_ 2	H417	KH=.447	KII=. 460	KH*.480	KH". 496	Кн 520	KB*.509	KH 499	КН 494	КН479	KB=.420	KH=.383	ANNUAL AVG. LOLP 0.0	ANNUAL AVAILABILITY 0.0	ANMUAL LOLP MAXIMUMS 0.0	ANNOAL LOLP MINIMONS 0.0
BATTERY CASACIT	_	FEB	K	APR	MAY	JUN	306	AUG	SEP	5	M	DEC	ANWUAL AVG. U	ANN	XXX	AN

9.99999 9.99939 9.9999 1.00000 9.9999 0.0000.0 9.9999 9.9999 6.6666.6 9.99999 9.9999 66666.6 66666.6 6.6666.6 9.99999 9.99999 9.99999 9.99999 9.9999 9.99999 1.00000 0.0000.0 9.9999 6.6666.6 66666.6 9.99999 66666.6 66666.6 9.99999 66666.6 66666.6 66666.6 66666.6 9.99999 9.99999 9.9999 0,0000.0 1.00000 1.00000 65666.6 9.9999 66666.6 9.99999 9.99999 66666.6 66666.6 6.6666.6 66666.6 9.99539 66666.6 66666.6 9.9999 9.9999 0.0000.0 66666.6 66666.6 66666.6 66666.6 9.99999 66666.6 9.99999 66666.6 66666.6 9.99999 66666.6 9.99999 9.99999 1.00000 9.99999 9.99999 0.0000.0 9.99999 9.99999 9.9999 66666.6 66666.6 6.6666.6 9.99999 9.99999 9.99999 9.99999 9.99999 18.8 1.00000 9.99999 00000 9.99999 1.00000 1.00000 6.6666.6 TILT ANGLE: 39.0
ALMATS: 1000.
ALMAT ANEA (SQ. METERS): 5.0
ARMAY EFFICIENCY (%): 10.0
BATTERY CAPACITY (kWh):
BATTERY FFICIENCY (%): 75.0 9.99999 9.99999 66666.6 66666.6 9.99999 6.666.6 66666.6 9.99999 9.99999 9.99999 9.99999 3.0 9.9999 0,00000 9.99999 9.99999 9.9999 9.99999 9.9999 1.00000 1,00000 9.99999 66666.6 9.99999 66666.6 66666.6 .00019 DUTY FACTORS & KWh/dav 9.99999 .48734 .51266 9.99999 9.99999 .00274 .00050 9.99999 .00155 .00019 .11844 .02850 9.99999 66666.6 66666.6 .00000 .96827 .36385 .03173 .36385 .00390 .00001 00000 .00000 .00001 .00000 .00020 .01276 KH=.383 KH=.499 ANNUAL AVAILABILITY 0.0 K3-.509 кн-..520 ANNUAL LOLP MINIMUMS 0.0 ANNUAL LOLP MAXIMUMS 0.0 KH-.480 AVG. LOLP BATTERY CAPACITY ANNUAL OF DAYS DEC 3 ģ SOC. SEP JUL ¥ ij X K APR

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CITY : WASHINGTON DC
LATITUDE 39.0
TILL ANG 139.0
LOAD (W. S): 1000.
ANRAY ARC '60. MITERS): 3.5
ANRAY EF. ENCY (#): 10.0
BATTERY E. CIENCY (#): 75.0 BATTER: "PACITY (MM):

NATTERY CABS 42		DUTY FACTORS & KI	m/day							
		6.3				25.04		.0		
OF DAY	. · · ·		2.5	0.0	4.5	9	0.0	12.0	18.0	100.04
	}					1.0		**		
JAN K	.417									
	****	9.9999	9.9999	9.9999	86850.6	86866.6	9.9999	0	9	
FEB KH-	KH447							•	5 7 5 1 - 1	
	.01579	9.99999	9.9999	9.99999	66666.6	0.99999	0000	0000	4	
MAR KH-	KH460							ă		
	.00005	9.9999	9.99999	9.99999	9.99999	9.99999	9.0000	0000		
APR KH.	KH480							1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	KA166.6	4.99999
	00000	9.99999	9.99999	9.99999	9.99999	66666° á	9.99999	0000		
MAY KH.	KH496							6665533	66663.6	7.9999
	00000	1.00000	9.99999	66666.6	65666.6	66666.6	9.99999	00000.6	00000	40400
JUN KH.	KH520	97(0)								*****
	•		****	65.65.65.65.65.65.65.65.65.65.65.65.65.6	08060.0	9.99999	66666.6	60666.	9.99999	66666.6
JUL KH.	KH=.509	.75458	9.99999	66564.6	999999	66666.6	00000	9 9 9 9		
AUG KH 499									56661.6	66666.6
	.00000	9.99999	9.9999	9.99999	9.99999	9.99999	66666.6	00000	00000	
SEP KH 494			·						666550	4.75.
	00000.	66666.6	9.99999	9.99999	6666666	9.99999	9.99999	066666	000000	0000
OCT KH479										621161
	.00007	9.99999	9.99999	9.99999	9.99999	9.99999	9.99999	9,44444	9	
NOV KH.	KH420 9.99999	9.99999	9.9999	9.99999	9.99999	9.9999				
DEC XH*.383	9.9999	9.99999	9.9999	9.9999	9.9999	9.99999	9			9.9999
ANNUAL AVG. LOLP 0.0	.25133	.90469	1.00000	1.00000	60000	0000			6666 6666	
AMMUAL Availability 0.0	.74867	.09531	0.00000	0.000				1.00000	1.00000	1.00000
APPROAL LOLP							00000	0.00000	00000	0.0000
0.0	9.99999	9.99999	9.99999	9.99999	9.99999	9.9999	9.9999	• • • • • •		
AMPUAL LOLP HINIMUMS									66666	7.3333
D.	00000	.10169	9.9999	9.9999	9.99999	9.99999	9.99999	9.99999	9.99999	9.99999

CITY: HUNICH,W GERMANY
LATITUDE: 48.1
TILT ANGLE: 48.1
LOAD (WATES): 2000.
AHRAY AFFA (SC. METERS): 60.0
ARRAY EFFICIENCY (%): 10.0
AATTERY EFFICIENCY (%): 75.0 BATTERY CAPACITY (kWh): 20.0

	700.00 48.0	9.99994	9.9999	9		9.9999	9.9999	9.99999	9.9999	9.99999	66666.6	66666.6	9.9999	9.99999	1.00000	0.0000	9.9999	9.9999
	75.04	9.99999	9.99999		9.99999	6.6666.6	66666.6	6.9999	9.99999	66666.9	9.99999	9.9999	9.99999	9.9999	1.00000	0.0000	9.9999	9.9999
	50.0% 24.0	9.99999	9.9999		66666.6	6.999.9	1.00000	1.00000	1.00000	1.00000	66666.6	66466*6	9.99999	9.9999	1.00000	0.0000.0	9.9999	1.00000
	37.54 18.0 1.1	6:66.6	64666		9.99999	.56076	.05800	.09915	.08258	.14505	1.00000	9.99999	9.99999	9.9999	.66213	.33767	9.93995	00050.
	25.04 12.0 1.7	1,00000	CECOL		.04873	.01570	.00444	.00902	.00720	.00759	.05514	.41046	9.99999	9.9999	.32075	.67925	9.9999	,00444
i	18.80	18101		18810.	.00450	.00273	+6000.	.00231	.00169	.00146	.00708	.02870	66+66*6	9.9999	.18745	.81255	9.9999	16000.
	12.54	69/00		.00133	.00038	.00041	.00019	.00051	.00036	.00028	.00073	.00225	9.9999	.67303	.14060	. 05940	9.9999	.0001
BATTERI CALACAS	****			.00032	11200.	.00018	01000,	.00026	.00019	.1000.	.00024	.00059	1.00000	.06948	.00942	.9105	1.00000	01000
	RS 6 kWh/dav 6.31 3.0		70000	90000	.00003	90000`	. 00005	.00012	60000	.00005	90000.	.00015	.04298	91800.	.00434	99566.	.04290	.00003
CY (3) :	DUTY FACTORS 6. 3.18 6. 1.5 3.	13.3	50000	.00002	.00001	.00001	.00000	.00002	.00001	.00001	0.00002	9.00004	.00173	69000.	.00022	87666.	.00173	00000
BATTERY EFFICIENCY	BATTERY D CAPACITY	Ī		161-161	KH 488	KH=.476	KII500	KH=.471	KB=.482	KH=. 490	KH460	KH= . 459	хн264	KII* . 357	ANNUAL AVG. LOLP 0.0	ANNUAL Availafility 0.0	ANNUAL LOLP MAXIMUMS 0.0	ANKUAL LOLP HIMIHUMS 0.0
BATTERY	BATT CAP!	OF DAYS	į	834	HAR	APR	MAY	SUR	JUL	AUG	428	5	202	DEC	ANG. D	ANNUAL AVAILA	ANNU	ANDC. MIN3

*

66666.6 66666.6 9.99999 9.99999 66666.6 66666.6 9.99999 66666.6 9.99999 100.04 24.0 1.5 9.99999 1,00000 0.0000.0 1.00000 66666.6 9.9999 1.00000 9.99999 9.99999 66666.6 6.6666.6 9.99999 9.99999 1.09000 9.99999 6666.6 75.0% 18.0 1.9 .00368 .40421 66666.6 .59579 9.9999 6666.6 66666.6 .01504 1,00000 .00732 .00368 .01038 .11301 9.99999 66666.6 9.99999 50.0% 12.0 2.9 .00014 66666.6 .65165 66666.6 .34835 66666.6 .01417 .72923 £000. .00034 £\$000° .00014 .00127 .42147 .01276 37.58 9.0 3.9 66666° ō .00001 .83219 66666.6 .16781 9.99999 9.9999 .00001 ,0000 .00062 .00002 .00003 .00001 .0000 .01268 .00027 .0000 25.0° 6.0 5.8 .00000 .83331 66666.6 1.30..00 .16669 6,6666.6 .00003 00000. .00000 00000. .00001 .00000 00000 .00020 00000 CITY: HUHICH, W GERHANY
LATITUDE: 48.1
TILT ANGLE: 40.1
LOAD (WATES): 1060.
ARRAY AREA (SO. HITERS): 40.0
ARRAY EFFICIENCY (%): 15.0
BATTERY CAPACITY (KWh): 35.0
HATTERY EFFICIENCY (%): 75.0 .0000 18.8% 4.5 7.8 +0000. .21048 .98223 .00277 .01777 .21048 .00000 *C000. *0000 .0000 ***0000**. 00000 *0000 .0000 3.0 .0000. .00000 .00370 .0000 .00032 99666. .00370 .00018 .0000 .0000. •0000 .0000. .0000. .0000. *0000 *0000. *0000. .0000 DUTY FACTORS & KWh/dev 3.14 6.34 2. 7 23.3 15. .00008 •0000 66666. .00003 .00001 90000. .0000° *0000. ,0000. *0000 *0000° .0000. *0000. .0000 .0000 *0000. 00000 .00000 .00000 1,00000 . AG300 00000. .00000 .00000 .00000 00000 00000. .00000 .00000 ,00000 .00000 ,00000 KB=.357 KH= . 459 KH=.264 XH=.460 XH=.482 KH. . 490 KH-.500 KH=.471 KH-.476 ANNUAL LOLP MINIMUMS 0.0 XH=.488 AVAILABILITY KII-.491 ANKUAL LOLP FAXIHUMS 0.0 KH-.474 ANNUAL AVG. LOLP BATTERY CAPACITY 0.0 0.0 ANMUAL OF DAYS 200 SEP ğ ğ AUG jur 305 ¥ JAH FER APA

9.9999

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CITY: HUNICH, W GENEANY
LATITUM: 1 48.)
TILT ANGLE: 148.)
LOAD (WATTS): 1200.
ARRAY AREA (SO. WETERS): 13.0
ARRAY EFFICIENCY (%): 13.0
BATTERY EFFICIENCY (%): 75.0 BATTERY CAPACITY (kWh):

BATTERY	DUTY PAC	CTORS & KHIN	//day	;		25.01	17.51	50.01	75.01	100.01
CAPACITY	3.16 6 1.5 3	, o.u.	4. 5.	12.54 6.0	9.0	12.0	16.0	24.0	36.0	0,-
f OF DATS	3.3	1.1	1:1	•	•	•	·	•	:	:
JAN KH474	474	9.9999	9.9999	9.9999	9.9999	66666.6	9.99999	9.9999	9.9999	9.9999
PEB KH491	491	1.00000	9.9999	9.9999	9.9999	9.9999	9.9999	9.99999	9.99999	9.9999
MAR KH". 498	488	.18534	9.9999	9.9999	9.9999	9.9999	6.683.6	9.9999	9.99999	9.9999
APR KH".476	.00044	.03173	1.00000	9.9999	9.9999	9.99999	9.99999	9.9999	9.99999	9.9999
MAY KH".	КИ-,500 .00018	.00674	.16419	9.9999	9.99999	9.99999	9.99999	9.99999	9.99999	9.9999
JUN KH-	KH471	.01276	. 30144	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.999
JUL KH*.	KH482	.01067	. 25468	9.9999	9.9999	9.9999	9.99999	9.9999	9.9999	9.9999
AUG KH*.	КН~490 .00026	.01283	.67783	9.9999	9.99999	66666.6	9.99999	9.9999	9.99999	9.9999
SEP KH".	KH".460	.17385	9.9999	9.9999	9.59999	9,91999	9.9999	4.99999	9.9999	9.9999
OCT RH*.	KH", 459	1.00000	9.9999	9.9999	9.9999	9.99999	9.99999	9.9999	9.99999	9.999
NOV KH"	KH 264 9.99999	9.9999	9.9999	9.9999	9.99999	9.9999	9.9999	9,9999	9.99999	9.9999
DEC KH	КИ357 1.00000	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.999
ANNUAL AVG. LOLP 0.0	. 16844	.45291	.78485	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.0000
ANWUAL Availability 0.0	Y .83356	.54709	.21515	0.0000	0.0000	0.0000	0.66600	0.0000	0.00000	6.0000
AMMUAL LOLP MAXIMUMS 0.0	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.9999	9.999
AMMUAL LOLP MIMIMUMS 0.0	.0001	.00674	. 18419	9.9999	666i6.6	66666.6	9.9999	9.9999	9.9999	9.9999

CITY: MUNICH, W. GERMANY
LATITUDE: 48.1

TILT ANGLE: 48.1
LOAD (WATTS): 1000.
ANHAY ANEA (50. HITEPS): 5.0
ANHAY FFFICIENCY (*): 10.0
BATTERY EMPICIENCY (*): 75.0
ANTERY EMPICIENCY (*): 75.0

100.0% 24.0	56666.6	66666	64666.6	9.99999	*6666° 6	66666.6	9.99999	66666.6	9,9999	9.9999	9.99999	66466.6	1.00000	0.0000	9.9999	9.9999
75.0% 18.0	9.99999	66600.6	66666.6	66666.6	9.99999	66666.6	9.99999	9.9999	66666.6	9.99999	9.9999	9.99999	1.00000	0.00000	9.9999	9.9999
50.04 17.0	66666.6	66606.6	66666°6	6666666	66666.0	66666.6	66666.6	66666.6	99999	66665.6	9.99999	9.99999	1.00000	0.0000	66666	9.9999
37.5% 9.0 6	9,99999	00600° 6	66666.6	66666.6	66666.6	66666.6	9.99999	66666.6	9.99999	9.99999	66666.6	9.99999	1.00000	0.0000	66666.6	9.9999
75.0 6.0 8.	66666*6	6060 0 °ú	ő6606°6	66666 66	60006.6	666666	66666.6	9.99999	66666.6	9.99999	66666.6	66666.6	1.00000	0.00000	66666.6	9.9999
18.84	66666.6	66666.6	66666.6	66666. ę	9.99999	66666.6	9.99999	6.99999	66666.6	66666.6	66666.5	9.99999	1.00000	0.0000	66566*6	9.9999
12.59 3.0	66666.6	66666.6	66666.6	60666.6	96666.6	9.99999	66666.6	9.99999	66566.6	66166.6	666áo*6	60666*6	1.00000	0.0000	66666.6	9.9999
/dav 9.44 2.2 2.2	9.99999	66666.6	66666.6	66666*6	1.00000	9.9999	1.00000	66666.6	55066.6	9.99999	9.99999	66666.6	1.00000	0.0000	9.99999	1.00000
TORS 6 kWh/dav 6.3t 1.5 3.3	66666.6	66666*6	9.99999	.08049	96100.	.00607	.00413	.00880	1.00000	9.99999	66664.6	66666.6	.59179	.40821	9.9999	.60196
DUTY FACTORS 3.1% .7 6.7	.00684	01000.	.00001	.00001	000000.	.00001	.00001	00000.	.00002	9 .00026	9.99999	9.99999	.16727	.63273	9.99999	00000
BATTERY CAPACITY OF DAYS	JAN KII47	FEB KH=.491	1.AR KH=.488	APR KH=.476	MAY KH*.500	JUN KH471	JUL KH=.482	AUG KH490	SEP KH=.460	ост кн∗.459	NOV KH=.264	DEC FH=.357	ANNUAL AVG. LOLP 0.0	ANNUAL AVAILABILITY 0.0	ANWUAL LOLP PAXIYUMS 0.0	AMNUAL LOLP MINIMUMS 0.0

CITY: MUNICH,W GERMANY
LATITUDE: 48.1

TILT ANGLE: 46.1
LOAD (WATTER): 1000.
ARRAY AREA FFEICHCY (N.): 10.0
BATTERY EPPICIENCY (N.): 75.0 RATTERY CAPACITY (PER): 6.0

DUTY PACTORS is with/day J.18		18.0		2			64666.6 66666.6 66669.6	66666'6 66666'6 66666'6	66666.6 66666.6	9.9999 9.99999 9.99999	86666.6 89899.9 9.99999.1	66666.6 9.99999 9.99999	66666, 6 66666, 6 68666,	66666.6 66666.6	66666.6 9.99999	61666.8 62696.8 61866.6	9,9999 9,99999 9,19999	1.00000 1.00000 1.00000	00000.0 000000.0 00000.0	66666 6 66666 6 66668 6	
CTORS & kWh/dhy 9.44	37.54	•	•	•								66666.6	66666.6	66666*	66666.6	9.99999	96666.6	1.00009	0.00000	66666.6	
CTORS & kWh/day 6.34 1.5 2.2 3.0 4.0 2.2 2.2 2.0 4.0 9.99999	25.04		2	1.0		9.99999	666666	66 966 6	9.99999	9.99999	666666	66666.6	9.99999	66666.6	9.99999	9.9999	9.99999	1.00000	0.00000	6.666.6	
1.55.0 6.33 1.55.0 7.99999 9.99999 9.99999 1.0000 1.0000 1.0000 9.99999 9.99999	-6.6.		÷.5	1.3		ó 5 6 6 6 6 6 6	6,9449	66666.6	66ú66°6	9.99999	66666.6	00066°6	66666.6	9.99999	66566.6	9.99999	9.99999	1.00000	0.0000	66666.	
1.55.0 6.33 1.55.0 7.99999 9.99999 9.99999 1.0000 1.0000 1.0000 9.99999 9.99999	13 60	16.21	3.0	2.0		66966.6	66566.6	6666666	6666666	9.99999	4.99999	66966*6	9.99999	66666°	66666.	9.99999	9.99999	1.00000	0.0000	60066.6	
1.55.0 6.33 1.55.0 7.99999 9.99999 9.99999 1.0000 1.0000 1.0000 9.99999 9.99999	;	3.6	2.2	2.7		9.99999	9.99999	9.99999	9.99999	9.9999	9.99999	66566*6	9.99999	66666.	9.99999	9.99999	9.99999	1.00000	0.0000.0	9.99999	
NYS 8.0 KII=-474 3.1% NYS 8.0 KII=-474 9.99999 KII=-491 .00940 KH=-476 .00000 KH=-476 .00000 KH=-470 .00000 KH=-482 .00000 KH=-490 .00000 KH=-490 .00010 KH=-459 .99999 KH=-357 99999	•	6.36	-	.0.		66666.6	9.99999	9.99999	9.99999	1.00000	1.00000	1.00000	9.99999	9.99999	9.99999	9.9999	9.9999	1.00000	0.0000	9.9999	
NYS NUS NUS NUS NUS NUS NUS NUS		11.1	;		•	9.99999	•	•	•		•	•						.25283	Y	9.9999	
BATTERY BATT CAPA CAPA JAN JAN JUL JUL JUL AUG AUG AUG ANG ANG ANG ANG ANG ANG ANG ANG	BATTINI	CABACTEV		34 44														ANG. LOLP	APRIAL AVAILABILITY 0.0	ANNUAL LOLP MAXIMUMS 0.0	AMMINAT. LOG.P.

<u>.</u>

CITY: CAMBRIDGE, U.K.

LATITUDE: 52.2

TILT ANGLE: 52.2

LOAD (WATTS): 2000

ARRAY AREA (50. HETENS): 60.0

ARRAY EFFICIENCY (4): 10.0

RATTERY EFFICIENCY (4): 75.0 RATTERY CAPACITY (KWh): 20.0

9.9999 9.9999 9.9999 0.0000.0 1.00010 9.9999 9.9999 9.9999 9.9999 9.9999 9.9999 9,99999 9.9999 9.99999 9.9999 100.04 .9999. 0.0000.0 9.9999 9.9999 1.00000 9.9999 9.99999 66666.6 9.9999 9.99999 9.9999 9.99999 9.9999 9.9999 9.9999 9.9999 75.0**1** 36.0 9.9999 1.00000 9.9999 0,0000,0 1.00000 9.9999 9.9999 9.9999 9.9999 9.99999 1,00000 9,99999 1.00000 9.99999 1,00000 9.9999 50.04 24.0 9.9999 9.9999 16866 71282. .83134 9.9999 9.9999 9.9999 .34067 .28217 1.00000 9.99999 ,35324 9.9999 9.9999 9.9999 9.99999 9.9999 .02692 .57458 .42542 9.9999 .48342 9.99999 .11747 9.9999 .02935 1.00000 .21023 .02761 .02692 9.9999 25.01 12.0 1.7 9.9999 .00688 .42159 9.9999 .57841 .64501 9.9999 9.9999 .02423 .04614 .00781 .03373 .00752 .28778 .00688 9.9999 9.0 9.9999 .00152 9.9999 . 28454 .71546 9.9999 .03064 9.99999 \$6100. .00522 .00462 .00187 .34521 .00544 .00152 90810 1.00000 12.5 .00069 9.9999 .16017 .13913 .60922 .00737 9.9999 .00181 .00084 .00149 .00091 .00442 .00195 .05065 69000. . 24265 DUTY PACTORS 6 kWh/dev 3.14 6.31 4.15 1.5 3.0 4.1 .00033 .23783 .97432 .02568 .23783 .00141 .03714 92000. .00043 .00041 .00041 .00033 .00067 .00094 .00737 .02054 .00455 90000. .99918 .00082 .00455 .00027 .00192 .0001 .0001 .0000 .0000 90000 .0001 .00020 .0000 KH-.384 KH-.278 KH-.434 KH-.396 KH-. 407 KH= . 434 KH-.443 AMMUAL Availability 0.0 KH-.376 KH-.394 ANMUAL LOLP MINIMUMS 6.0 KH=.333 KH-.331 AMRUAL LOLP MAXIMUMS 0.0 101 BATTERY CAPACITY 0.0 I OF DAYS ANMUAL AVG. Š ţ JUL Š SEP K APR MA JAN FEB MAR

CITY: CAMBRIDGE, U.K.
LATITUDE: 52.2
TILT ANGLE: 52.2
IJUAC (WATTS): 1000.
ANDAY ANEA (SO, METERS): 40.0
ANDAY EFFICIENCY (%): 10.0
BATTERY EFFICIENCY (%): 75.0 BATTERY CAPACITY (kWh): 35.0

	50.01 75.01 100.01 12.0 18.0 24.0	•	66666'6 66666'6	66666°6 66666°6	66666°6 66666°6 56666°6	66986*6 66666*6 . 66666*6	.07410 9.99999 9.99999	.05810 9.99999 9.99999	69666.6 9.99999 9.99999	1.00000 9.99999 9.99999	666666 66666666666666666666666666666666	66666'6 66666'6	66666'6 66666'6	46666°6 66666°6	.76716 1.00000 1.00000	.23284 0.00000 0.00000	66666.6 66666.6
	37.58	ب. پ	66666.6	66660.6	6666666	.12365	.00353	903316	.00424	.04556	.73821	66666.6	66666.6	9.99999	.57658	.42342	66666.6
	25.0%	æ.	66566.6	66666.6	.03584	.00159	.00016	.00023	.00023	.00112	.00198	.12480	9.99999	66666*6	.34716	.65284	66666°6
11.00	18.85	7.8	6066 6	.24453	.00109	.00019	.00004	90000.	90000	.00017	.00013	.00292	9.99999	9,99999	.27076	.72924	000
CITY (KWD)	12.54	11.7	.02343	.001	+0000.	.00002	.00001	.00001	.00001	.00003	.00001	.00008	.10629	9.99999	.09432	.90568	0
BATTERY CAPACITY (KEN) :	/dav 9.4% 2.2	15.6	.00103	.00018	.00001	.00001	00000.	.00001	.00001	.00001	.00000	.00001	.00294	.11001	.00952	.99048	.0011
15.0	FORS & kWh/dav 6.3%	23.3	.00005	.00002	00000	. 00000	00000	00000	00000.	00000	*0000	00000	60000.	.00064	.00007	. 99993	
EHCY (1) :	DUTY FACTORS	46.7	33	31	00000.	94	43	.00000	.00000	9690000.	00000.	384	292	278 .00001	.00000	1.00000	
BATTERY FFFICIENCY (%)	BATTERY Capacity	OF DAYS	КН*.333	КН≖.331	КН=.376	KH=.394	KH=.443	КН≖.43	KH=.434	КН•.396	KH=.407	KH*.38	KH=.292	KH=.278	ANNUAL AVG. LOLP 0.0	ANNUAL AVAILABILITY 0.0	ANKUAL LOLP HAXIMUMS
BATTE	20	1 OF	JAN	FEB	HAR	APR	MAY	JUN	JUL	AUG	SEP	007	NON	DEC	ARN	AVA	ANK

CITY: CAMBRIDGE, U.K.
LATITUDE: 52.2

TILT ANGLE: 52.2

LOAD (WATTS): 2000.
ANRAY AREA (FO. METERS): 13.0

ANRAY EFFICIENCY (%): 15.0

BATTERY CAPACITY (NW):

	100.0% 48.0		9.99999	9.9999	9.9999	9.99999	66666.6	66656.6	9.9999	66659.6	99999	9.99999	9.99999	9.9999	1.00000	0.0000	9.9999	9.9999
	75.0% 36.0	!	9.9999	9.9999	9.99999	9.9999	66666.6	9.99999	9.9999	9.99999	9.99999	9.99999	9.9999	9.9999	1.00000	0.0000	9.9999	9.9999
	50.04 24.0	:	9.9999	9.99999	9.99949	66666.6	9.99999	66666*6	9.99999	66666.6	9.99999	9.99999	9.99999	9.9999	1.00000	0.0000	9.9999	9.9999
	37.54	•	9.9999	9.9999	66666.6	65666.6	9.99999	9.99999	9.99999	66666.6	9.99999	6666.6	9.9999	9.9999	1.00000	0.00000	. 9.9999	9.9999
	25.04	•	9.9999	9.99999	66666.6	9.9999	9.99999	9.99999	9.99999	9,99999	9.99999	9.99999	9.99999	9.99999	1.00000	0.0000.0	9.9999	9.99999
)	16.01	ب	66666.6	9.99999	9.9999	9.99999	9.99999	66666.6	9.99999	9.99999	9.99999	66656.6	9.99999	9.9999	1.00000	0.0000	9.9999	9.9999
frank LLT	12.54	= ,	9.9999	66666.6	9.9999	9.9999	66666.6	9.99999	9.9999	9.99999	9.99999	9.9999	9.99999	9.9999	00000.1	9.0000	9.9999	6:66
BATTERY CAPACITY (APRIL	9.48	1:1	66666.6	9.99999	9.9999	9.99999	1.00000	.93291	1.00000	9.9999	9.9999	9.99999	9.9999	9.9999	.99441	. 10559	9.9999	.93291
: 75.0 BAT	ORS 6 kWh/dav 6.3% 3.0	1:7	9.99999	9.9999	9.9999	.62462	.04393	.04315	.04772	.26661	1.00000	9.99999	9.9999	9.9999	.66884	.33116	9.9999	.04315
	BUTY FACTORS	3.3	3	1.00000	.03006	4.00678	3.00161	.00195	.00206	.00563	.00702	.05645	9.99999	9,99999	.34263	.65737	9.9999	.00161
BATTENY EFFICIENCY (4)	BATTERY CAPACITY	or DAYS	KH+.333	KH331	KH376	KH=. 394	KB= . 443	Кн=. 434	KH=.434	KB396	KH407	KH•.304	KH 292	KH=.278	ANG. LOLP 0.0	ANNUAL Availability 0.0	ANNUAL LOLP MAXIMUMS 0.0	ANNUAL LOLP MINIMUMS 0.0
BATTE	Č	10	JAN	FEB	A A	APR	MAY	JUN	JUL	AUG	438	8	MOM	2	ANMA	AVAILA AVAILA 0.0	ANN	AMM

9.99999 6.6666.6 0.0000.0 66666.6 1.00000 66666.6 66666.6 66666.6 66666.6 66666.6 66666.6 66666.6 66666.6 66666.6 66666.6 66666.6 75.0% 18.0 6.666.6 9.99999 1.00000 0.0000 66666.6 66666.6 66666.6 9.99999 66666.6 9.99999 66666.6 66666.6 66666.6 9.99999 66666.6 66606.6 50.04 12.0 9.99999 9.99999 0.0000 66666.6 1.00000 66666.6 66666.6 66666.6 66666.6 66666° ó 66666.6 66066.6 66666.6 66666.6 6666666 65666.6 37.58 9.0 6. 65666.6 66666.6 0,00000 65666.6 1.00000 66666.6 66666. 6 66666.6 66666.6 66666.6 66666.6 66666.6 66666.6 66666.6 66666.6 9,9999 66666.6 25.04 6.0 00000.0 66666.6 1.00000 66666.6 66666.6 9.99999 66666.6 66666.6 66666° ó 6.6666.6 66666.6 66666.6 66666.6 6.6666.6 66666.6 18.8% 1.5 9.99999 LOAD (WATTS): 1000.
LOAD (WATTS): 5.0
ARRAY AREA (SO. HETERS): 5.0
ARRAY ELTICIENCY (t): 10.0
BATTERY EFFICIENCY (t): 75.0 BATTERY CAPACITY (KWH): 9.99999 0.0000 1.00000 66666.6 66666.6 66666.6 9.99999 9.99999 66666.6 66666.6 6666666 6666666 66666.6 66666.6 3.0 66506.6 .04158 9.99999 66666.6 1.00000 0.0000.0 66666.6 9.99999 66666.6 66666.6 66666.6 66666.6 6.6666.6 66666.6 66666.6 66666.6 66666.6 66666.6 2.2 DUTY FACTORS 6 kWh/dev 3.1% 6.3% 2. 7 1.5 2. 6.7 3.3 2. .23759 .76241 66666.6 66666.6 1.00000 66666.6 66666.6 .05342 66666.6 .05389 .04158 9.99999 66666.6 66666.6 9.99999 .0000 .65713 .34287 9.9999 66666.6 00060. .00054 .0000 .00011 .00080 66666.6 66666.6 CAMBRIDGE, U.K. KH-.292 KH=.278 KH=.384 KH=.434 KH=.434 ANNUAL AVAILABILITY 0.0 ANNUAL LOLP MINIMUMS 0.0 KH=.376 LATITUDE : 52.2 TILT ANGLE : 52 ANNUAL LOLP MAXIMUMS 0.0 KII-.331 ANNUAL AVG. LOLP 0.0 CAPACITY BATTERY # OF DAYS Ş Š AUG SEP JUN 305 APR ξ¥ NYC ¥ FER

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	75.04	66666.6	66666.6	66666.6	9.99999	9.99999	6.99949	9.99999	9.99999	66666.6	9.99999	9.99999	66666.6	1.00000	0.0000	66666.6	66666*6
	50.0% 12.0	6.000 p. 0	9.99999	9.99999	6.99999	9.99999	66666.6	9.99999	9.99999	66666.6	96666.6	69666.6	9.99999	1.00000	0.0000	9.9999	6.999.
	37.5% 9.0	66666.6	66666*6	66666.6	9.99999	9.99999	9.99999	9.99999	66666.é	66666*6	9.99999	9.99999	66666.6	1.00000	0.00000	\$ 99999	66666.6
	25.00	ú0406*b	6,000,0	6.000	9,99999	66666.6	66666.6	9.99999	9.99999	69666.6	9.99999	66666.6	66666.6	1.00000	0.00000	9.9999	66666.6
e.9	18.89 2.4	66666.6	66600.6	66666.6	66666.6	9,99999	66666.6	9.99999	66666.6	9.99999	9.99999	66666.6	66666.6	1.00000	0.0000.0	9,9999	66666.6
CAPACITY (KWh.)	12.54 3.0 2.0	6666666	66666.6	9.99999	6666666	66666.6	66666.6	9.99999	6666.6	6.99999	9.99999	9.99999	66866*6	1.00000	0.0000	9.9999	66666*6
TERY	/dav 9.48 2.2 2.7	9.99999	66666.6	66666.6	66666.6	66666.6	9.99999	9,99999	9.99999	66666.6	66666.6	9.99999	6.9999	1.00000	0.00000	9.99999	9.99999
ė	TORS & kWh/day 6.3% 9 1.5 2 4.0 2	9.99999	66666.6	66666.6	9.99999	9.9999	9.99999	9.99999	9.9999	9.99999	9,99999	9.99999	9.99999	1.00000	0.0000	9.99999	9.9999
CITY : CAMBRIDGE, U.K. LATITUDE : 52.2 TILT ANGLE : 52.7 LOAD (WATTS) : 1000. ARRAY ANGA (50. METERS) : ARRAY EFFICIENCY (1) : 10.0 BATTENY EFFICIENCY (2) : 75.0	DUTY FACTORS 3.1%	9,99999	331	.376 9.99999	94	43	34	34	96 .00128	07 .03901	84 9.99999	92 9.99999	78 9.99999	.50378	,49622	96999.6	.00004
CITY : CAMBRIDGE, LATITUDE : \$2.2 TILT ANGLE : \$2. LOAD (MATTS) : 1 ANNAY ANATAS : 1 ANNAY EFFICIENCY RATTENY EFFICIENCY	BATTERY CAPACITY F DAYS	XII333	XII=.3	КН≡.3	KH=.39	KH=.443	KB=.434	KH=.434	KH=,39	KH*.407	KB*.38	KH=.292	КН".278 9	ANNUAL AVG. LOLP 0.0	ANNUAL AVAILABILITY 0.0	ANRUAL LOLP MAXIHUMS 0.0	ANNUAL LOLP Minimins 0.0
CITY LATI TILT LOND ARRA ARRA ARRA	80 b	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	9	NON	Dad	ANNU.	ANNUAL AVAILA 0.0	ANWUAL LA MAXIHUMS 0.0	ANNUAL LA Minimems 0.0

9.99999 75.04 36.0 1.00000 9.99999 9.99999 9.9999 9.99999 9.99999 9.99999 9.99999 9.99999 9.9999 9.9999 9.9999 0.00000 9.9999 9.99999 1.00000 9.99999 50.04 24.0 9.99999 9.99999 9.9999 9.99999 9.9999 9.99999 9.99999 6.99999 9.99999 6.6666.6 0.00000 9.99999 9.99999 9.99999 .98810 .85723 .85723 9.99999 37.58 18.0 1.1 1,00000 1.00000 1.00000 9.99999 9.99999 .01190 9.99999 9.99999 9.9999 9.99999 9.99999 46663.6 . 33099 .14112 .51750 .66131 9.99999 9.99999 9.99999 .08111 9.9999 11180. 9.99999 .08497 9.99999 9.99999 9.9999 .33869 9.99999 CITY: JUENEAU, ALASKA
LATITUDE: 58.4
LATITA ANGLE: 58.4
LOAD (MATTS): 2000.
ANHAY AREA (50. METERS): 60.0
ANHAY EFFICIENCY (4): 10.0
BATTERY EFFICIENCY (4): 75.0 BATTERY CAPACITY (MMh): 20.0 .03795 18.81 9.0 2.2 .09300 9.99999 .54900 9.99999 9.99999 .38907 .02155 .02273 .02369 1.00000 9.99999 .45100 9.9999 .02155 .06233 .38790 .00552 .01681 9.99999 9.99999 .52751 .02313 .00618 1.00000 9.99999 .61210 9.99999 .00406 .00406 .00930 1.00000 .00427 .07189 .00582 .00153 .00642 9.9999 9.9999 . 28258 9.99999 .00153 .00262 .00292 .01491 .28061 .71742 DUTY FACTORS 6 kWh/dev 3.1% 6.3% 1.5 3.0 13.3 6.7 .10278 .00313 9.9999 .00216 .21738 .00055 .00179 .02411 .11380 .00055 .01017 .00120 .00104 .00131 .88620 9.99999 .00346 .00024 .00059 .00105 .00015 .00026 .00032 .00067 .44059 .44059 .00161 .96212 .00015 .03788 KH-. 284 KH=.280 KH=.350 KH-.428 KH=.392 KII=. 402 KH-.371 KH*.349 KH=.325 KH*.391 KH-.228 ANNUAL Availability 0.0 ANNUAL LOLP MAXIMUMS 0.0 ARMUAL LOLP Himimums 0.0 CAPACITY BATTERY ANNUAL AVG. LOLP I OF DAYS 0.0 JAN FEB 55 JUL Aug **82P** ţ Š

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CITY: JUENDAU, ALASKA
LATITUDE: 58.4
TILT ANGLE: 58.4
LUAD (WATTS): 2000.
ARRAY EFFICIENCY (0): 10.0
BATHAY EFFICIENCY (1): 10.0
BATHAY EFFICIENCY (1): 15.0
BATTERY CAPACITY (kWh):

	100.04 48.0 .1	9.99999	9.9999	66666.6	9.99999	66666.6	66666.6	. 99999	66665.6	9.99999	66666.	66666.	9.9999	1.00000	0.0000	9.9999	9.99999
٠	2	•	•	•	•	•	•	•	ń	ň	•	•					
	75.08 36.0	9.9999	9.9999	9.99999	9.9999	9.9999	9.99999	9.99999	9.99999	9.99999	9.99999	9.9999	9.9999	1.00000	0.0000	9.9999	9.9999
	50.00 24.0 .2	9,99999	9.99999	66666.6	66666.6	66666.6	9.99999	9.99999	66666.6	€€366.6	9.99999	9.9999	9.9999	1.00000	0.0000.0	9.9999	9.9999
	37.54 18.0	9.99999	66666*6	65666.6	9.99999	66666.6	6.6666.6	9.99999	9.99999	6.99999	66666.6	9,99999	9.99999	1.00000	0.0000	9.9999	9.9999
	25.04 12.0	9.99999	9.99999	i e6666°6	66666.6	66666.6	9.99999	9.9999	9.99999	9.9999	9.99999	9.99999	9.99999	1.00000	0.0000	9.99999	66665.6
	18.61 9.0 6	9.99999	9.99999	6666666	6666666	66666°6	66666.6	9.9999	9.99999	9.99999	9.99999	9.99999	9.99999	1.00000	0.00000	9.99999	9.9999
	12.51 6.0 .B	9.99999	9.99999	9.99999	9.9999	66666.6	66666.6	9.9999	9.9999	9.99999	9.99999	9.99999	9.99999	1.90000	0.0000.0	9.9999	9.9999
	9.48 4.5 1.1	9.99999	9.99999	9.99999	9.99999	1.00000	1.00000	9.9999	9.9999	9.9999	9.99999	9.9999	9.9999	1.00000	0.0000	9.9999	1.00000
	525 & kWh/day 6.34 3.0 1.7	66	66666.6	9.99999	.25894	.15066	.13455	. 26245	1.00000	9.99999	9.99999	9.99999	9.99999	.73388	.26612	9.9999	.13455
	DUTY FACTORS 6 3.1% 6. 1.5 3.	99999	00000	.03961	.00477	.00643	.00706	.01092	9.02167	5.11772	9.99999	9.99999	86 9.99999	. 43402	. 56598	9.9999	.00477
MITENI EFFICIE	_ E	H= .32	KH350	Кн-, 391	KH=.428	KII 402	КН•.392	KH371	KH=.349	KB=.325	XH=.284	KH280	KH228	ANNUAL AVG. LOLP 0.0	AMMUAL Availability 0.0	ANKUAL LOLP MAXIMUMS 0.0	ANNUAL LOLP MINIMUMS 0.0
MILLER	BATTERI CAPACI:	NAC	FEB	HAR	APR	MAY	JUN	JUL	AUG	SEP	50	80	DEC	ANNUAL AVG. L	AVAILA 0.0	ANHUAL U MAXIMUMS 0.0	AMPU

CITY: JUFNEAU, ALASKA
LATITUDE:: 5%.4
TILT ANGLE: 58.4
TOAD (WATTS): 1000.
ARBAY AREA (SC. METERS): 5.0
ARBAY EFPICIENCY (%): 10.0
ARBAY EFPICIENCY (%): 75.0 BATTERY CAPACITY (WHA): 5.0

	100.0% 24.0 .2	666666	÷6666 6	66666.6	66656*6	9.99999	9.99999	9.99999	65666 .6	66066*6	9.99999	66666.6	66666.6	1.00000	0.0000	9.9999	9.9999
	75.0% 18.0	6 66666°0	5 - 6666°6	66666.6	66666.6	66666.6	65666.6	9.99999	9.99999	9.99999	66666.6	666666	66666.6	1.00000	0.0000	9.9999	9.9999
	50.00 12.0	, 66666°6	66666*6	66666.6	66666.6	66666.6	9.99999	66666.6	66666*6	9.99999	66666.6	66666.6	9.99999	1.00000	0.0000	9.99999	9.9999
	37.5% 9.0	6 66666.6	9 99999	66666.6	66666.6	66666.6	9.99999	66666.6	9.99999	66666.6	6.9999	66666.6	66666.6	1.00000	0.0000	6666 á * 6	6666.6
	25.01 6.0 8.	5 65666.0	000066*6	60666.6	66666*6	66666.6	9.99999	66666.6	9.99999	66666.6	9.99999	66666.6	9.99999	1.00000	0.0000	9.9999	9.99999
•	18.84 4.5 1.1	66666.6	á666b°6	66666.6	66666.6	66666.6	9.99999	9.99999	9.99999	66666.6	66666.6	66666.6	9.99999	1.00000	0.00000	66666.6	9.9999
CAPACITY (KWO)	12.54 3.0 1.7	5 - 6666°6	9.9999	6666666	66666.6	9.99999	9.99999	9.99999	66666.6	65666.6	9,99999	9.99999	96666.6	1.00000	0.0000	9.99999	66666*6
	2.2 2.2	6 66666.6	666666	66666.6	66666.6	9.99999	9.99999	9,99999	9.99999	9.99999	66666*6	66666.6	9.99999	1.00000	0.0000.0	66666*6	9.99999
75.0 BATTERY	ns & kWh/dav 6.3% 1.5 3.3	66666.6		66666.6	1.00000	.39601	. 25269	1.00000	9.99999	66666.6	9.99999	9.99999	9.9999	.88739	.11261	66666*6	.25269
3	BUTY FACTORS 3.1%	66666	66666.	.03819	.00041	2.00075	2.00094	1.00190		.30408	9.99999	9.99999	9.99999	.44604	.55396	9.9999	.00041
ATTENY EFFICIENCY	BATTERY CAPACITY P. DAYS	XH321	KH*.350	Кн 391	KH=.428	KH=.402	КН•.392	KH=.371	KH= . 349	KH=.325	KH284	ЖН=.280 9	KH=.228	ANHUAL AVG. LOLP 0.0	ANMUAL Availability 0.0	AMMUAL LOLP MAXIMUMS 0.0	ANNUAL LOLP MIRIMUMS 0.0
ATTER	BATTER CAPACI		837	MA.P.	APR	HAY	JUN	JOE	AUG	425	964	20	DEC	ANG.	ANMUAL AVAILA 0.	MAX	ANN

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LATITUDE: 58.4
TILT ANGLE: 58.4
LOAD (WATES): 1000.
ARMY ERFO (50, METERS): 3.5
ARMY EFFICENCY (%): 10.0
BATTERY EFFICIENCY (%): 75.0 RATTERY CAPACITY (WWh) 66666.6 66666.6 66666.6 6666666 9.99999 6666666 66666.6 12.51 3.0 2.0 0.0000.0 9.9999 1.00000 66666.6 66666.6 66666.6 9.99999 66666.6 66666.6 6666666 66666.6 66666.6 66666.6 66666.6 9.4 9.99999 DUTY FACTORS 6 kWh/day 66666.6 9.99999 1.00000 0.0000.0 9.99999 9.99999 9.99999 9.99999 9.99999 9.99999 9.99999 66666.6 66666.6 66666.6 66666° b 66666.6 .58858 .41142 9.9999 .00084 9.99999 9.99999 .05714 96666.6 9.99999 .00308 .00084 .00089 .00103 66666.6 66666.6 KH-.228 KH=.284 KH-.325 KH=.349 KB-.371 KH-.402 KH=.392 KH-.391 KII=.321 ANMUAL LOLP MAXIMUMS 0.0 ANNUAL LOLP MININGMS 0.0 AVAILABILITY AMMUAL AVG. LOLP 0.0 BATTERY 0.0 ANNOAL # OF DAYS DEC ğ ğ ğ Ы JUN HAY APR ZYZ 7.5 L

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APPENDIX B

STRUCTURAL ANALYSIS

A CHECKLIST FOR THE ANALYSIS OF THE MERADCOM STRUCTURE

- Will the trailer overturn in the wind
- Will the trailer overturn when taking normal turns at high towing speeds
- Will the tie-downs hold during movement over rough terrain
- Will the support rods hold during winds from the front and back
- Will the support have lateral stability for winds from the side
- Will the trailer fill with rain closed or open
- What strengthening is required for the trailer to hold the batteries
- How strong must the fold-out arms be
- How strong must the outriggers be
- How strong must the pinned joints of the foldout arms be
- How tolerant will the design be to uneven terrain
- are the erection forces higher than the normal forces
- Will the structure buckle -- especially the support rods
- What is the most severe tilt including wind loads and the angle of the support
- How load-bearing must the soil be
- Will cannon fire impose severe loads on the structure (e.g., lateral loads
- How will the structure behave—'er wind gusts -- what is the natural frequency as compared to the vortex shedding frequency
- Will the structure hold one man standing on it -- for repairs, construction or against instructions
- Are the transporting loads higher than the erected loads
- What are the hold-down loads

- Can the batteries be placed along the centerline, or must they be located near the axle
- What is the natural frequency of the battery/trailer combination
- Keep the c.g. near the axle for ease of towing and rotating once on site
- What are the best materials to be used
- From what height can the trailer be dropped without damaging the power system
- How will the panels be installed and supported along the slant height
- Is a horizontal brace needed to keep the rails from spreading apart will a wire suffice or must a compression member also be provided
- How will the back brace resist lifting with a wind from the rear
- How will the front brace resist lifting with a wind from the front
- Should guy wires by used to resist the uplift/overturning
- Can the array and trailer be rotated after erection or are the loads too great
- Perform rigid-body analyses as well as deformable-body analyses
- Take the wind-load data from recent reports
- Watch the dead weight as well as the live load

FORCES ON THE COLLECTORS

According to a study of array wind loads performed by Boeing, the combined front and rear (suction) forces could result in normal force coefficients of 2.0. Values of 2.5 were measured by VPI investigators, who performed tests of wind-tunnel models. The negative implies the force (and wind) are from the rear. Cp of 1.51 was observed when the wind was from the front. Gusts giving Cp = -3.93 to 5.61 occurred.

At a wind velocity of 60 knots (101 FPS), the wind pressure is 14.63 PSF. For now, we will assume the structure to be flexible enough to withstand the gusts; however, we will design to Cp = -3.05 to +3.05 to provide sufficient safety factor. Then the wind force is \pm 44.6 PSF.